signal corps reports on army research in . . .

UG
.S58
Vol 13
No 2
1959

Components

March 1959

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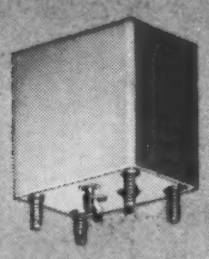
700 STOCK ITEMS to cover every electronic application.

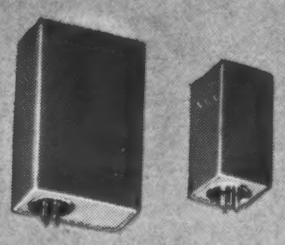
300 HERMETIC ITEMS . . . proved to MIL-T- 27A, eliminates test delays.

All with the UTC plus value . . . HIGHEST RELIABILITY IN THE FIELD.

FILTERS



LOW PASS HIGH PASS BAND PASS
60 to 12000 CYCLES.



TELEMETERING
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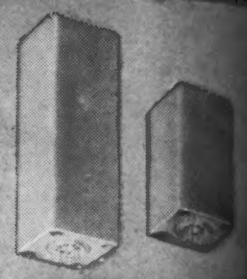

TELEGRAPH
425 to 2975 CYCLES.

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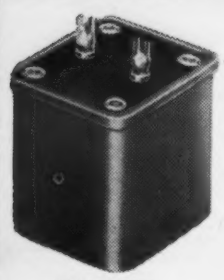
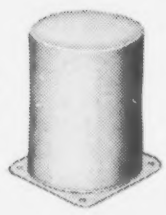


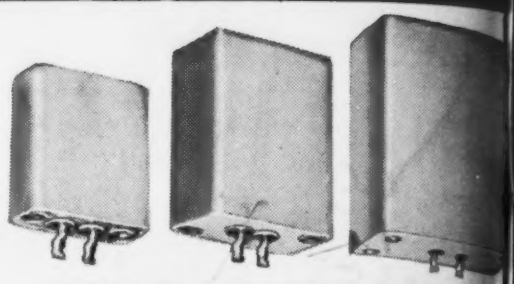
VARIABLE STANDARD

VARIABLE HERMETIC

DECADE INDUCTOR



LOW FREQU.
TO 2500 HYS.



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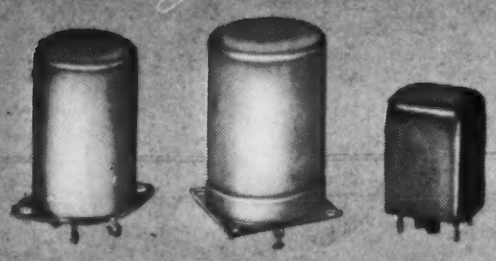

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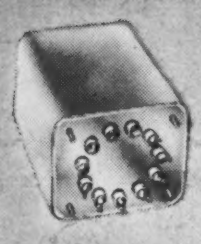

POWER TO
1200 VCT.

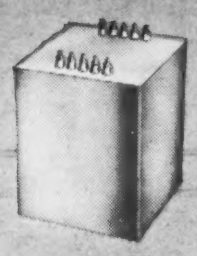

PLATE TO
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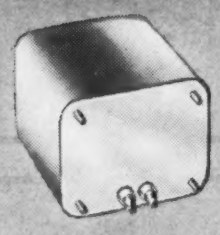

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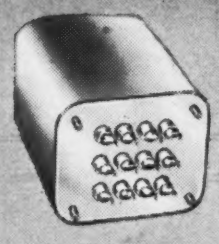

FILAMENT TO
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FILAMENT 400
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TRANSISTOR AUDIO

MINIATURE HERMETIC
HIGHEST POWER

SMALLEST SIZE

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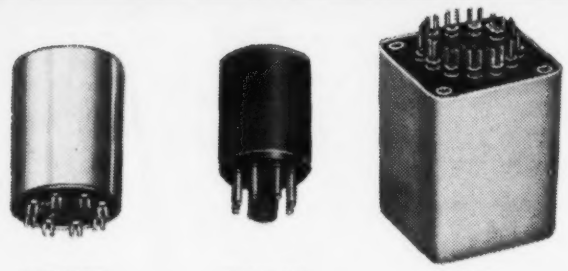

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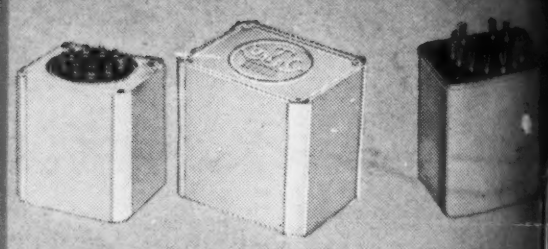

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HIPERMALLOY

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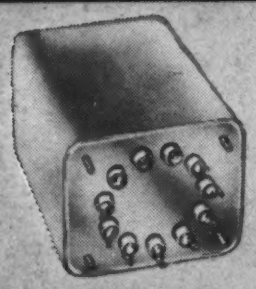

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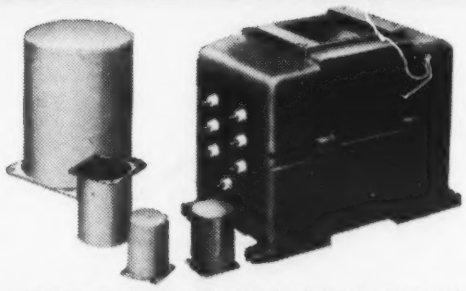

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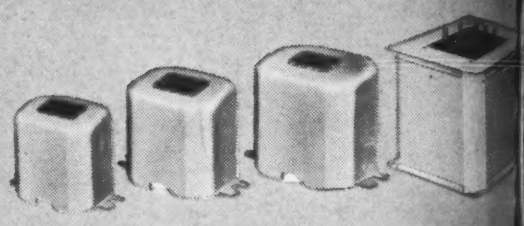

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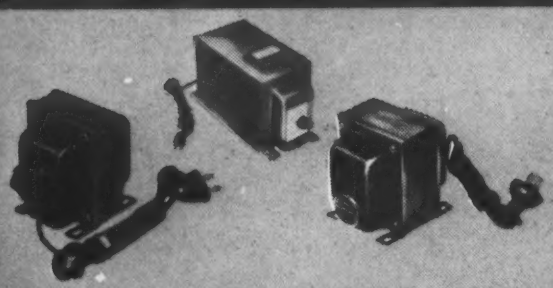

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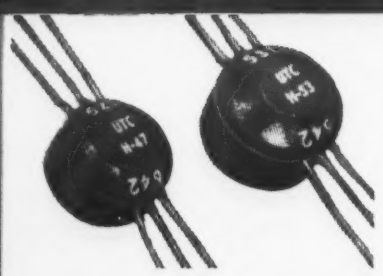

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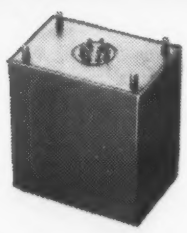

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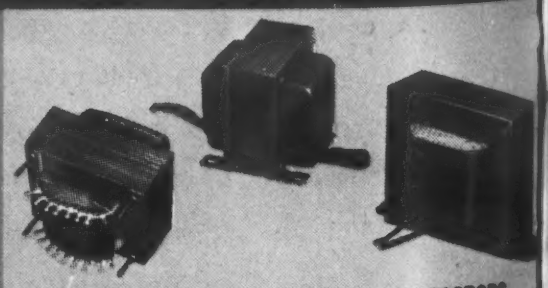

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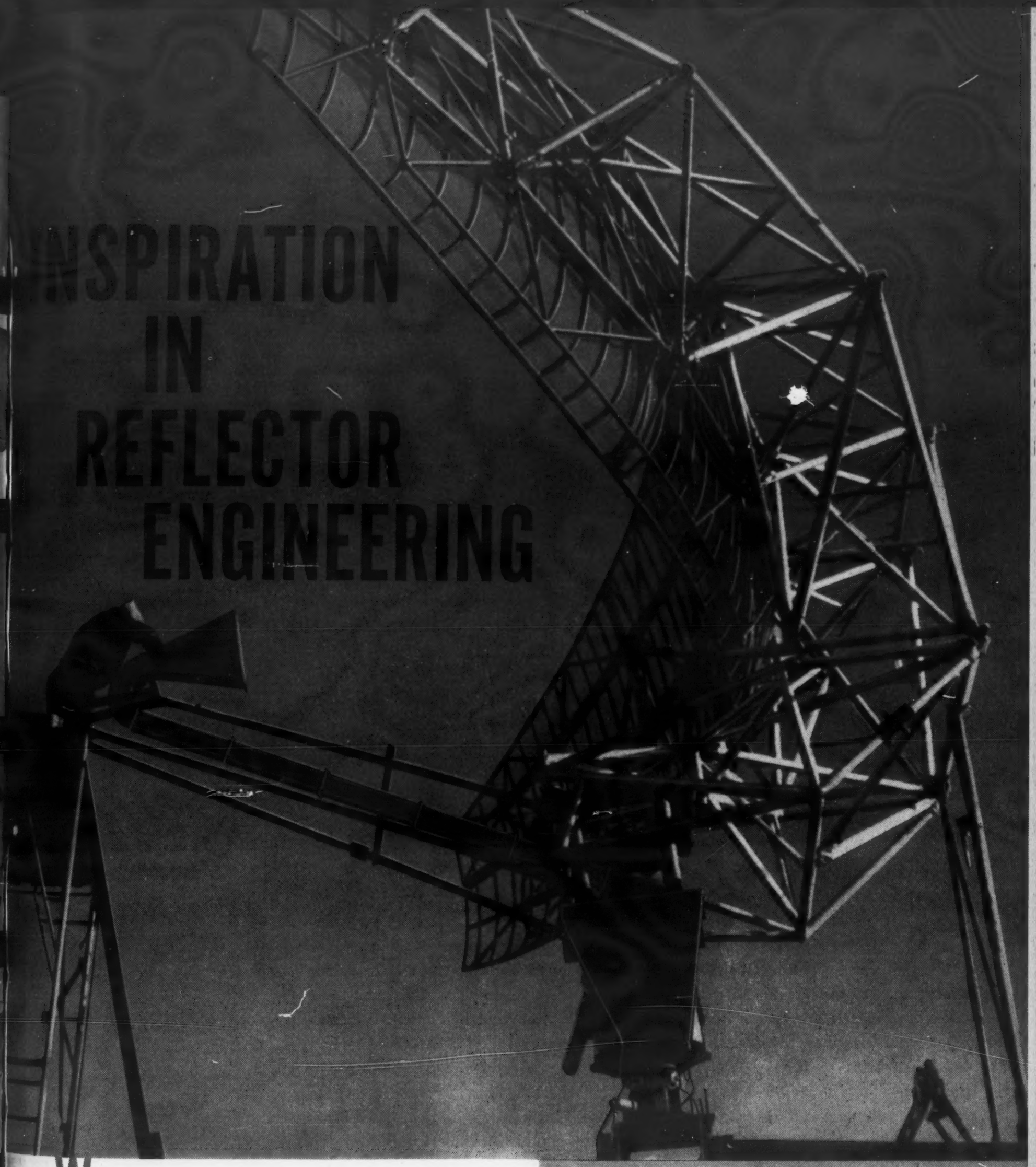

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Down-To-Earth **SOLUTIONS** *to Out-Of-This-World* **PROBLEMS**

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- Radar Antennas
- "Trans-Horizon" Antennas
- Tropospheric Scatter
- Ionospheric Scatter

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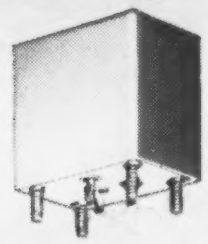

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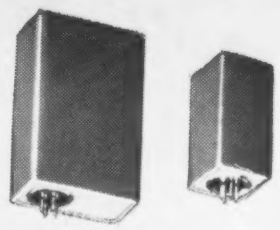

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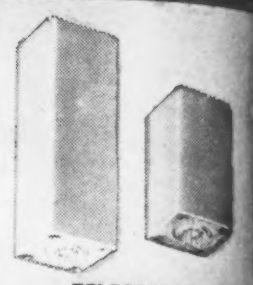

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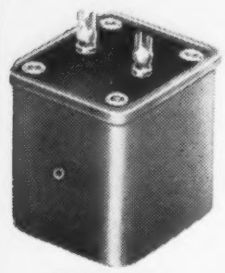

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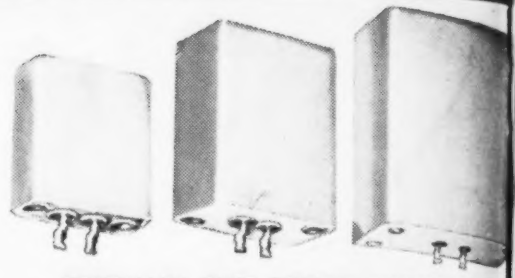

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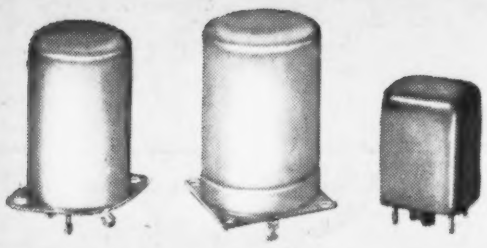

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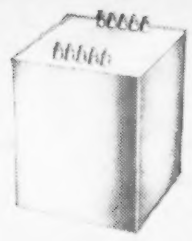

PLATE TO
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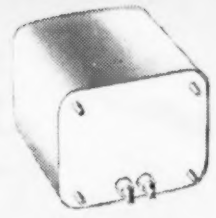

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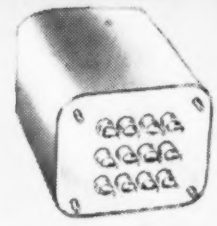
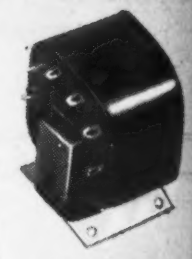


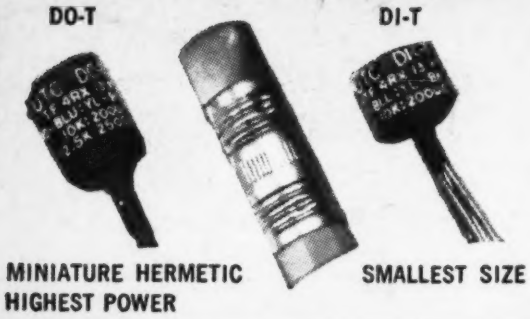
FILAMENT TO
5V 60A.



FILAMENT 400
CYCLE.

TRANSISTOR AUDIO

DO-T DI-T



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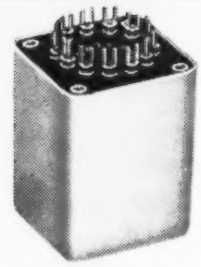
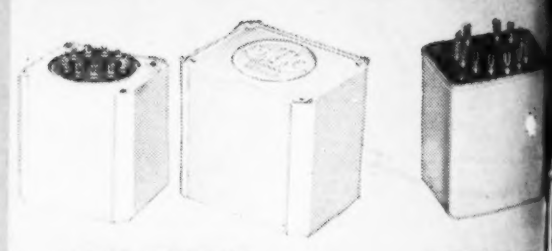


ULTRA
COMPACT

HIGHEST FIDELITY



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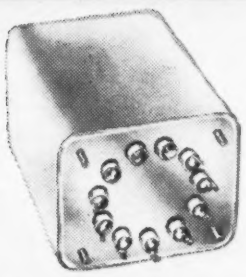

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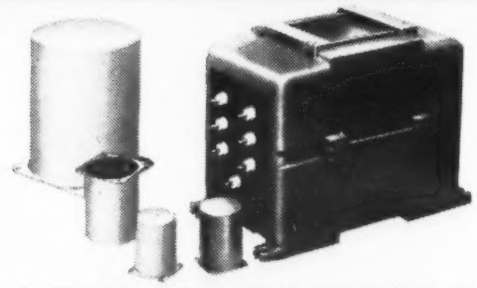

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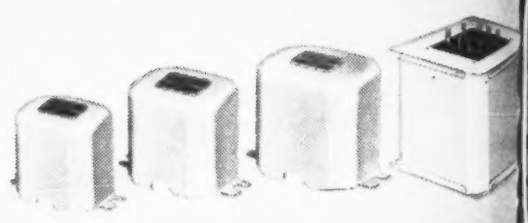

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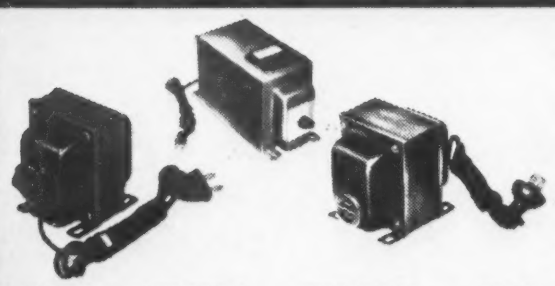

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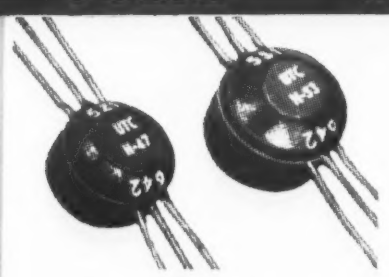

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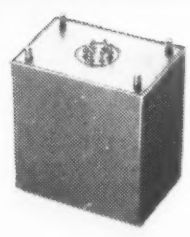

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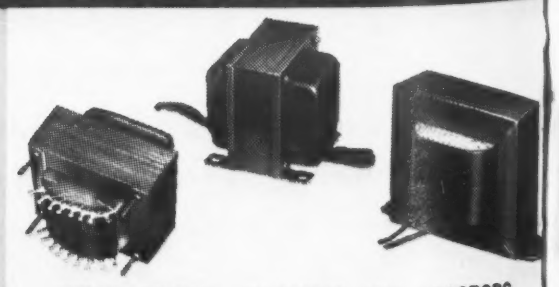

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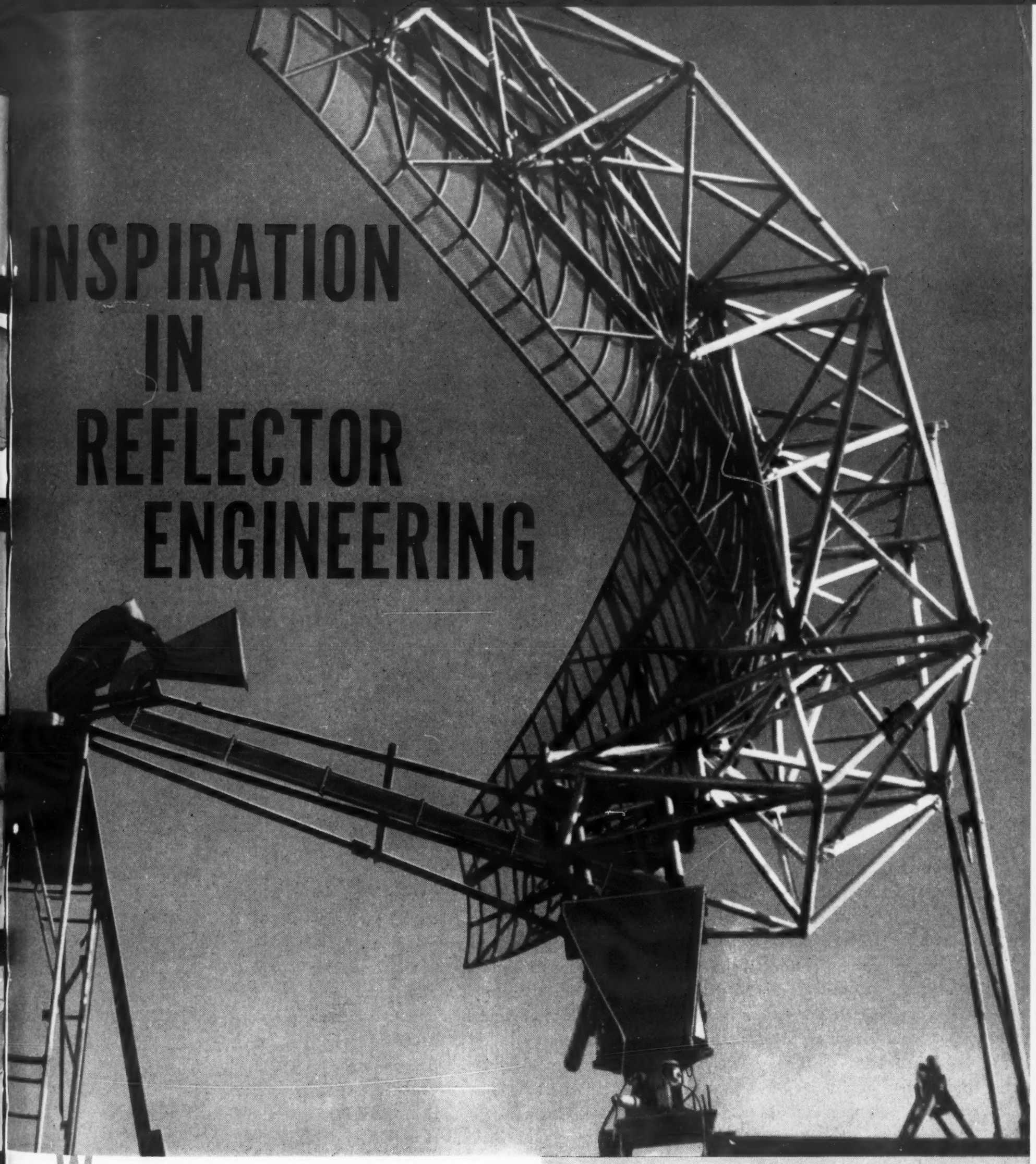

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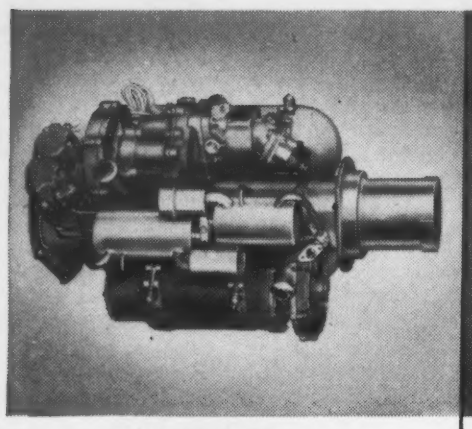
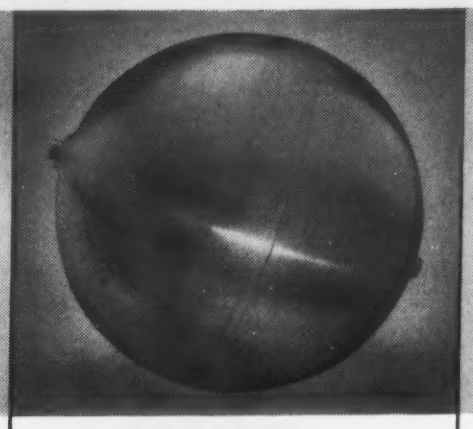
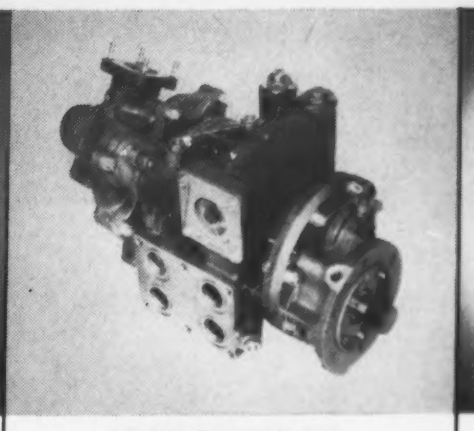
Tropospheric Scatter
Ionospheric Scatter



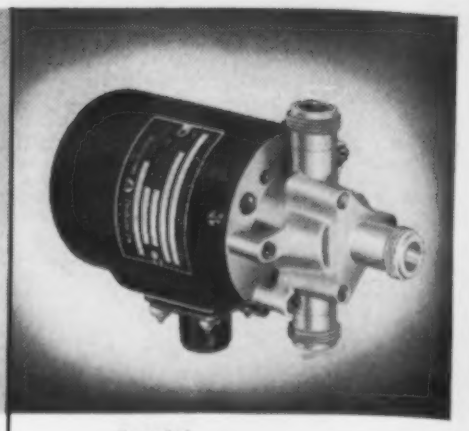
Solid-propellant auxiliary power unit



Titanium missile pressure vessel



Combination main and after-burner fuel pump



Coaxial switch

Four-stage turbine wheel

100,000 rpm turbine-driven alternator

Missile gyro ground test unit

Jet engine case assembly

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CONTENTS

Part I

Acknowledgements 5

Statements on Components by Leading Executives 6

Part II

Introduction by General O'Connell, Chief Signal Officer, USA 7

Comprehensive Report on Components
U. S. Army Signal Research & Development Laboratories

- New Parts for New Electronics 8
- Miniature—Sub-miniature—Micro-miniature 12
- Power for the Future 14
- From Micro-watts to Mega-watts 18
- Today's Research for Tomorrow's Components 22

FEATURE ARTICLES

Part III

Some Thoughts on the NASA Program 27
Dr. Homer J. Stewart

Possibility or Capability? 30
Colonel Charles W. Gibbs, USA

Tools of the Space Age 32
Brigadier General W. Walter Watts, USAR

Decision and Communication 34
Lieutenant General James D. O'Connell, USA

The Age of Printed Circuitry 40
John D. Cochrane

Components: The Parts of the Picture 42
Major Orvil S. Ostberg, SigC, USAR

Technology and Defense 49
Donald A. Quarles

Highlights of the Cold Cathode Tube Development 50
Dr. A. K. Wright and Dr. A. M. Skellett

The Services of ARINC Corporation 51
C. R. Knight

The Challenge of Space, Part II 61
Dr. Gilford G. Quarles

Photoprogress 64
Frank Smith

DEPARTMENTS

Part IV

Signalgram 39

Association Affairs 68

AFCEA Group Members Directory 70

AFCEA Chapters and Chapter Officers Directory 72

Chapter News 74

New Products 82

Index to Advertisers 92

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INTRODUCING SIGNAL'S COMPONENTS ISSUE

LETTER OF APPRECIATION

On behalf of the entire membership of the Armed Forces Communications and Electronics Association, I wish to extend my sincere appreciation to the U. S. Army Signal Corps and particularly to the U. S. Army Signal Research and Development Laboratories at Fort Monmouth, New Jersey, for their cooperation with SIGNAL *Magazine in making possible the publication of the following five chapters on components.*

Frederick R. Furth
National President, AFCEA

★ ★ ★ ★

Special Individual Recognition

Colonel Harold McD. Brown graduated from West Point in 1937 and joined the U. S. Infantry only to be detailed in 1939 to the Signal Corps. During World War II, he served in a command position in England, France, Belgium and Germany. In late 1945, Colonel Brown returned to the United States and became Assistant Signal Officer, Headquarters, First Army. Following duty in Hawaii (1946-49) he served with the Procurement and Distribution Division in the Office of the Chief Signal Officer.

He is a graduate of the Signal School, the Armed Forces Staff College and the Army War College. For distinguished service, he was awarded the Legion of Merit. Prior to his present position as Commanding Officer, USASRDL, 1 May 1958, Colonel Brown served with distinction on the Department of Defense Munitions Board, as Chief of the Signal Corps Technical Service Board for Research and Development and as Chief, Electronic Warfare Department at Fort Huachuca, Arizona.

First Lieutenant James P. McNaul was born in Madison, Wisconsin, on August 20, 1933. He received his B.S. degree in Electrical Engineering from the University of Wisconsin in 1956 and was awarded a commission in the Signal Corps.

Lt. McNaul's first assignment was at the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J., as Assistant Project Officer of Project MONMOUTH, a communications system and frequency compatibility study. He served in this capacity until May 1958 when he joined the Technical Staff of the Electronic Components Research Department of USASRDL.

He is a member of the Armed Forces Communications and Electronics Association, Institute of Radio Engineers, Kappa Eta Kappa, and an associate member of the American Institute of Electrical Engineers. He is presently a member of the Administrative Committee of the IRE Professional Group on Radio Interference and is serving as treasurer.

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Editor's Note: All of the above played a major role in making this special issue possible. We are profoundly grateful to: Colonel H. McD. Brown for his leadership and direction; Lt. J. P. McNaul for his devoted interest, outstanding guidance and over-all helpfulness; Mr. W. L. Doxey, who originated the idea for the series of articles; Mr. S. F. Danko for his contribution to the completion of the series; Mr. B. H. Christenson for his cover design; Mr. S. B. Pierce for his excellent art work and to all others who contributed to the Component Project. We also wish to thank Brigadier General Earle F. Cook, Chief, Research and Development Division, and Lieutenant Colonel Kenneth E. Shiflet, Office of the Chief Signal Officer, for their invaluable assistance.

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VIEWS BY LEADING EXECUTIVES
on
Components in the Communications and Electronics Field

Paul S. Darnell, Director, Military Component Development
Bell Telephone Laboratories, Inc.

It would seem that the important position of electronic components in the field of communications is so self-evident that discussion of the point is superfluous. The success or failure of an electronic communications system is in large measure the success or failure of a complex aggregation of electronic components, which in turn depends on the integrity of those components. In some cases, redundancy lessens the demands on the parts; in others, the quality of the part under conditions of use is the controlling factor in the performance of the system.

The enchantment which comes from the contemplation of a system as a functional entity has tended to relegate the importance of its parts to a secondary or lower order, just as the facade of an imposing architectural creation obscures the framework within. In recent years, however, the rapidly increasing complexity of electronic systems with the consequent unlimited growth in quantities of parts, has forced attention to the units from which the system is fashioned. As we head toward system concepts which involve an infinitude of components, we must also work toward components which never fail; otherwise the system will be of no use. The realization of this fact has finally projected electronic parts into a position of importance and consequent increased attention. At long last, it appears that the pieces of which communications and other electronic systems are composed are to be given the place "in the sun" which they deserve.

P. E. Haggerty, President
Texas Instruments Incorporated

When just a little more than ten years years ago Bardeen, Brattain and Shockley, then all of the Bell Telephone Laboratories, made the transistor a reality, they ushered in a whole new era in electronics. The transistor is important, not just because of its own amazing properties and what they mean to electronics, but because it was the big breakthrough the industry needed to make it focus on a new frontier. This new frontier is the very structure of matter itself. Just as the transistor came into being because its creators through their research gained a deep comprehension of semiconductor materials at the structure of matter level, so also we can expect a whole host of new and exciting components from the work of the thousands of scientists and engineers now peering behind this new frontier. The Maser and the parametric amplifier already have resulted, and it is safe to predict these are just the beginning. As our insight into the solid state deepens, we will be able to construct true solid-state circuits performing complete electronic functions and obsoleting our concepts of components such as the transistor, diode, resistor, capacitor or inductance as we hold them today. Solid-state circuits promise size reductions of 1000 to 1 from present printed circuit concepts, large reductions from present concepts of miniature module circuits, and almost immeasurable improvement in reliability, simplicity and flexibility. What the transistor began, the solid-state circuit will bring to fruition, and the boundary of electronics will be so immeasurably broadened that however exciting we may think the history of electronics has been to date, what we now face in our technology is a revolution.

D. R. Hull, President
Electronic Industries Association

The remarkable advances in electronic devices and equipment and their vital role in military operations, their growing industrial applications, and their varied contributions to home entertainment are well known. However, the importance of the little bits and pieces, the components that are required for modern electronic systems, are often overlooked.

Complex electronic equipment in this Space Age requires component parts that are considerably more precise, stable, and reliable than those used in yesterday's radio, and these parts must be properly used within their tolerances or limitations. Outstanding advances have been made in the design and manufacture of components by parts manufacturers and by end equipment producers in their application. It is vital that component research and development, including basic research in materials, be fully and continually supported, both by the Military and Industry, in order that this technical progress will not falter.

We must not forget Benjamin Franklin's sage warning that for want of a horseshoe nail a rider was lost.

G. Ross Kilgore, Manager, Applied Research Department, Baltimore Laboratory
Electronic Tube Division, Westinghouse Electric Corp.

Too little emphasis has generally been given to the electronic components area in military electronic planning. The term "components" itself belies the important role of these devices, for they are not merely the parts of building blocks of a system but often a single device holds the key to the whole electronic system. This is especially true of the area of electron devices, i.e., electron tubes, transistors, and related solid-state devices.

Frequently in the planning of military electronic systems the development of a new electron tube has been given belated or inadequate consideration when in fact the tube was the heart of the system. What is needed is recognition in the early system planning of the relative importance of the electron tube, with the systems engineers making known to tube developers the system requirements at an early stage; and the electron tube engineers disseminating information on advanced electron devices to system developers and exchanging new ideas and concepts with them.

The importance of electron devices should be recognized and given strong support. The key role of electron devices in space age electronics promises to be even more impressive than the past. Tubes combining electron beams and semiconductors are offering an extension of our vision for surveillance and other new tubes offer major improvement in information storage, new methods of millimeter wave generation, etc. With solid-state devices in their infancy, even now atomic and molecular devices forecast a new era in receiver sensitivity. The concept of "molecular system engineering" now evolving in the laboratory will have a profound effect on the future of military electronics.

Ernst Weber, President
Institute of Radio Engineers

The reliability of all systems and equipments, whether simple or complex, rests upon the proper performance of their components. Obviously, increased pressures upon better and more efficient system and equipment design transmit directly into more severe requirements upon component performance, taxing the ingenuity and inventiveness of the components manufacturers. Even though it seems hard to make component research glamorous to the average engineer, we cannot afford relaxation in our efforts to achieve better, more reliable, and more economical component products. Every effort in materials research, in improvement of production technique, in development of dependable testing procedures, eventually contributes to better component performance and thus to the advancement of equipment design.

We must, however, be mindful that there is no place for wishful thinking, either on the part of the components manufacturer, or on the part of the designer who is the normal user of the components, prescribing ratings, types and makes in every particular instance. Unfortunately, electronic engineers are not generally cognizant of and perhaps do not fully respect the safety factors required in competent design, and often expose components to severe overloads and over-stresses.

In addition to the realization of the prime importance of components in electronic equipments and systems, it appears indicated to promote mutual educational efforts in order to assure proper use and design application of the components in accordance with the established ratings and tolerances. Only when reliability becomes the byword of electronic equipment can we assure the respect and universal acceptance by the public, whether it be government, user, industry, or consumer.

the signal corps reports on:

army research

in

Components

Lt. Gen. J. D. O'Connell
Chief Signal Officer, USA

TODAY'S United States Army, together with its sister services, is the most versatile military instrument in the world.

To achieve the sustained mobility, firepower and command control to cope with modern warfare's realities, the Army has taken advantage of the tremendous technological advances of science and industry. New principles of combat operations have been evolved and new military organizations created. New methods are continually developed for training the still indispensable element—The Individual Soldier. The result is a flexible combat instrument capable of applying power with complete discrimination—backed by dynamic logistical and technical support.

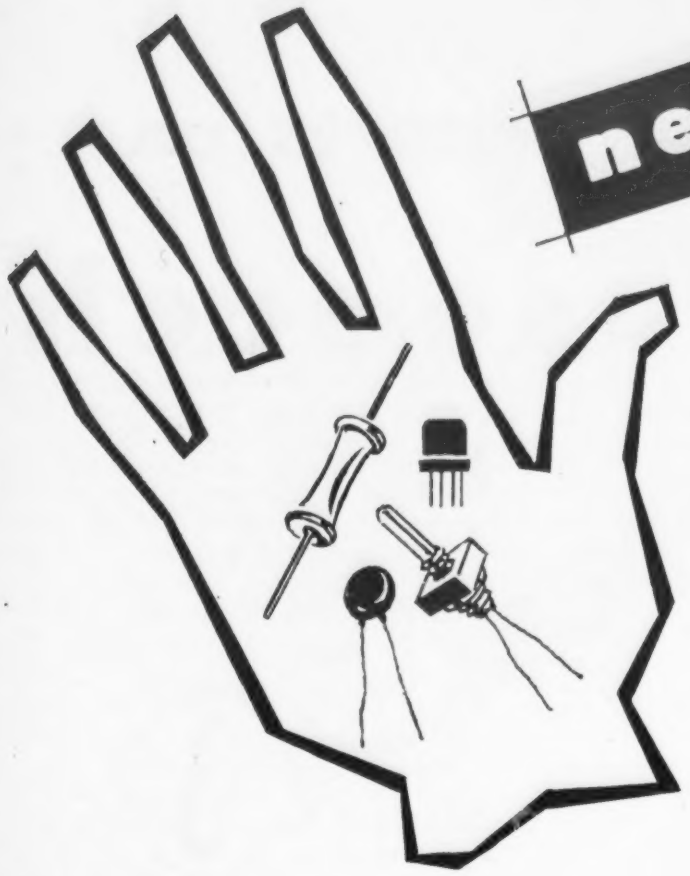
It is the Army Signal Corps' responsibility to provide the commander with the means for positive command control. Within this mission are systems for strategic and tactical communications, target acquisition and surveillance, coordination and control for missiles, electronic warfare, data handling and information display, and avionics for Army aircraft.

Among Army facilities for this purpose, the Signal Corps maintains an active electronics research and development program at the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J. This program seeks to tap resources for electronics progress wherever they may be—in the military or the commercial laboratory, in the industrial facility, in the foundation, or in the university. We must increase this activity several fold.

But the consistent development of better equipment and systems is not possible *unless* we devote equally aggressive attention to developing the myriad components of which they are comprised. The military equipment designer cannot be content to hope that the steadily advancing state-of-the-art will give him the tools he needs *when* he needs them. It is only through vigorous attack on every technical barrier, every reliability weakness, and every size and weight limitation that our art will move ahead at the pace we must have.

Lead-time reduction—to which the Army is directing such concentrated effort—is irrevocably bound up in componentry development. The scientists and engineers working in the field of components must anticipate the equipment engineer by several years to give him the tools he needs to put his equipment idea into effect.

I hope that the following articles will provide some insight into what is going on in one area of this vast field of components work.



new PARTS for new electronics . . .

THERE are over 100 distinct families of electronic parts that are of research and development interest to the United States Army. Among the more prominent of these we include relays, switches, resistors, cables, capacitors, coils, transformers . . . the elemental parts that are used to shape and control the electronics impulses in equipments. Each of these electronic parts has its own history of development . . . a history that is unique, a technology that is peculiar, and applications that are specific. Accordingly, research and development in this diverse components field is performed by specialists . . . experienced in the technologies and requirements of these individual parts families. Today, a substantial portion of the electronic (research and development) R&D effort is being applied to this parts development, reflecting the growing recognition that new capabilities of future systems and equipments are directly dependent on attainment of new capabilities within these building blocks of our equipment.

There is one popular and much abused term used by many in presenting new accomplishments in this components area . . . the term "breakthrough," originally intended to signify a revolutionary advance in the field . . . a breaching of a tough technical barrier.

The Bell Telephone Laboratory transistor, the Signal Corps' printed wiring and the radar concept are perhaps the better known examples of "breakthroughs" which have opened new horizons for electronic exploitation. It is difficult at times to draw a line between a "breakthrough" and just an "incremental improvement" . . . since even an improvement, at times, may represent an effective gain in operational performance, a substantial economy in design, or elimination of a serious maintenance and logistics problem. The cherished breakthroughs, though few and far between, do exist in almost every disciplined R&D establishment; the Fort Monmouth Laboratory has made effective contributions in this regard in the 20 years of R&D activity in the specialized parts field.

The following discussions of parts developments are intended to give the historical and the forward look in certain selected parts areas—evolutions of the many parts which are taken for granted by equipment users.

Ferrites

A man-made magnetic ceramic, called *ferrite*, is playing a major role in the shaping of our new electronics. Though in their natural form they are the oldest magnetic material known to man (the lodestone, a ferrite, was discovered by the Greeks), it is only since World War II that they have been synthesized with sufficiently accurate and dependable properties to make them suitable for practical electronic applications. The basic characteristic of ferrites that makes them superior for many applications to the more conventional magnetic metals such as iron, nickel, cobalt, or their alloys, is that the ceramic ferrites have high resistivities . . . that is, they are insulators rather than conductors. As a result, electrical losses are very low even at very high radio frequencies. Most of today's applications of ferrites are in the 100 kc to 100 mc range (where the magnetic metals are useless) with some unique new uses in the microwave region.

The intriguing possibilities of this material have been the force behind the Signal Corps' keen development interest in ferrites for military usage. This development activity has been very fruitful and the Army's effort thus has yielded radio frequency ferrites that are now commercially available and suitable for frequencies up to 50 megacycles. Materials suitable for frequencies up to 200 megacycles are close to commercial realization, and work is underway for materials that can be used up to 500 megacycles.

Although there have been very many applications where these radio frequency ferrites have been successfully used, (rf coils, I-F transformers, chokes, antennas, computers memories, etc.) there are two new uses pioneered by the Signal Corps, which are of particular interest. One is the use of ferrites in a non-mechanical tuning unit for search receivers. The elimination of bulky mechanical drives with their inherent slow speeds made possible very rapid scanning by the new all-electronic means, at the same time permitting a very substantial reduction in size and weight of the countermeasures receivers. Another new application was in broad-band radio frequency power transformers needed for coupling field transmitters to their antennas. These broad-band coupling functions have had to be performed up to now with bulky, complex and expensive

networks called baluns. Not only are the new ferrite transformers very much smaller and lighter, they also have a considerably broader bandwidth, and can be made for only a fraction of the cost of the complex balun. (See Figure 1.)

Ferrites have also been developed having a so-called "square hysteresis loop" characteristic, a property ideally suited for making a synthetic memory for military computers. The Laboratory's development of this unique material and its subsequent commercial availability, is now the base for extensive use of such material in such computers as the Lincoln Laboratory's "Whirlwind," the IBM 600 series, the Remington Rand "Univac" and dozens of others. (See Figure 2.)

Ferrites have also made possible some revolutionary innovations in microwave "hardware" because of still another unique property they possess . . . that is, microwave energy could be made to pass through ferrite in one direction and not in the reverse direction. As a result, devices have been produced that would have been altogether impossible without ferrites. The microwave isolator is one such example . . . energy from the magnetron of a radar set can reach the antenna with negligible loss; however, any energy reflected from the antenna (due to mismatch) is absorbed by the isolator and thus prevented from reaching back to the magnetron, where it would materially reduce its efficiency. Varieties of such "*microwave ferrites*" out of the Laboratory's program are used in such other new devices as: circulators, attenuators, phase shifters, and power limiters.

All such microwave ferrites require a biasing magnetic field for operation, and the magnetic field required increases as the frequency of operation is increased. At the very high microwave frequencies, say about 25 kilomegacycles, the biasing field required is so large as to pose serious practical problems of construction, weight, and bulk of the magnet accessories. A very effective solution to this magnet problem was effected by another Laboratory development of a new family of ferrite-like materials which in effect supplied their own magnetic fields internally. The members of this new materials family have different characteristics adapting them to different frequency ranges, making it now possible to operate the devices up to 100 kilomegacycles without the large external magnets.

Piezoelectric Filters

The ferrites are almost perfect examples of the quest of research and development for new effects in nature, new phenomena from which new classes of materials and new parts functions could be created. One other such phenomena . . . *piezoelectricity* . . . discovered well over 100 years ago is still being exploited today to produce new simple devices to replace some of the more complex assemblies that we have used heretofore. Piezoelectricity is characterized by the change in the physical dimensions of certain materials when they are subjected to an electrical stress . . . such as by applying a voltage. By properly selecting the material and its dimensions, it is possible to devise a *resonator* which physically contracts and expands only over a narrow range of frequencies. The quartz crystal so widely used in our communication equipment is an example of such a piezoelectric resonator.

At frequencies higher than a few megacycles, only the quartz crystal filter will provide the selectivity required for today's military communications equipment. This component, one of the newest, will contribute much toward relieving the overcrowded frequency spectrum. It will permit closer channel spacing and will offer a direct means for increasing reliability. Up to now, equipment designers have been forced to resort to systems of multiple-frequency conversion in radio receivers in order to obtain required equipment performance. With the availability of VHF quartz filters, however, single conversion is possible, thus reducing circuit complexity and increasing over-all efficiency and reliability. Other benefits will be shown in the reduction of size, weight, and power requirements —all important considerations for the modern mobile army.

High frequency crystal filters which operate to 40 mc are now being commercially produced. These filters, with bandwidths ranging from one cycle to several hundred kilocycles, have been made possible by new design techniques and simplified circuitry. Eliminating the need for multiple frequency conversion, the small rugged filters are already beginning to find wide use in many AM, SSB, and FM receivers as well as single-sideband generators. Further progress in the development of quartz resonators will make possible the extension of crystal filter ranges to 100 mc and higher. Filter bandwidths in the order of 1 to 5 mc may be achieved, permitting the application of such filters to wide-band systems such as pulsed radar.

High frequency quartz crystal fil-

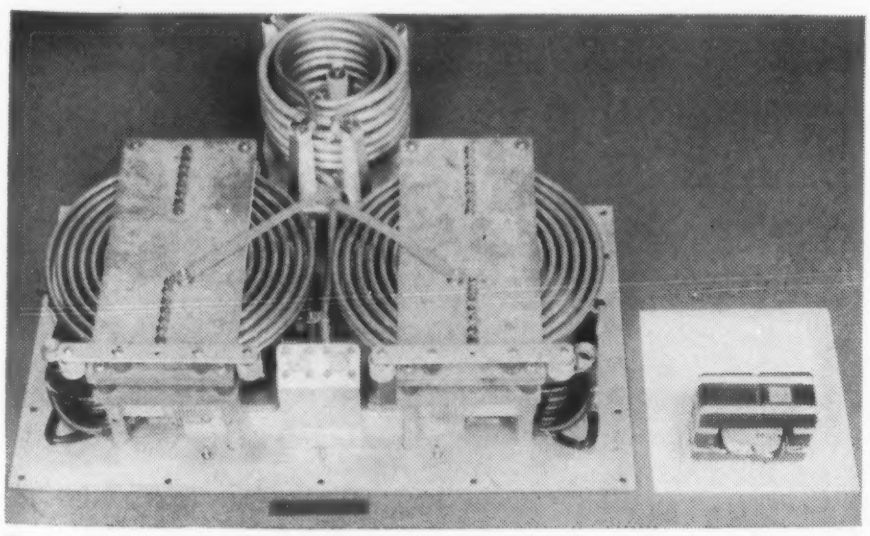


FIGURE 1

Ferrites have greatly increased our capabilities for RF transformer design. The small ferrite transformer shown on the right has the same power rating (1 kw) and a much broader bandwidth than the clumsy balum coil shown on the left. Weight and size savings such as these can have significant effects on our field equipments.

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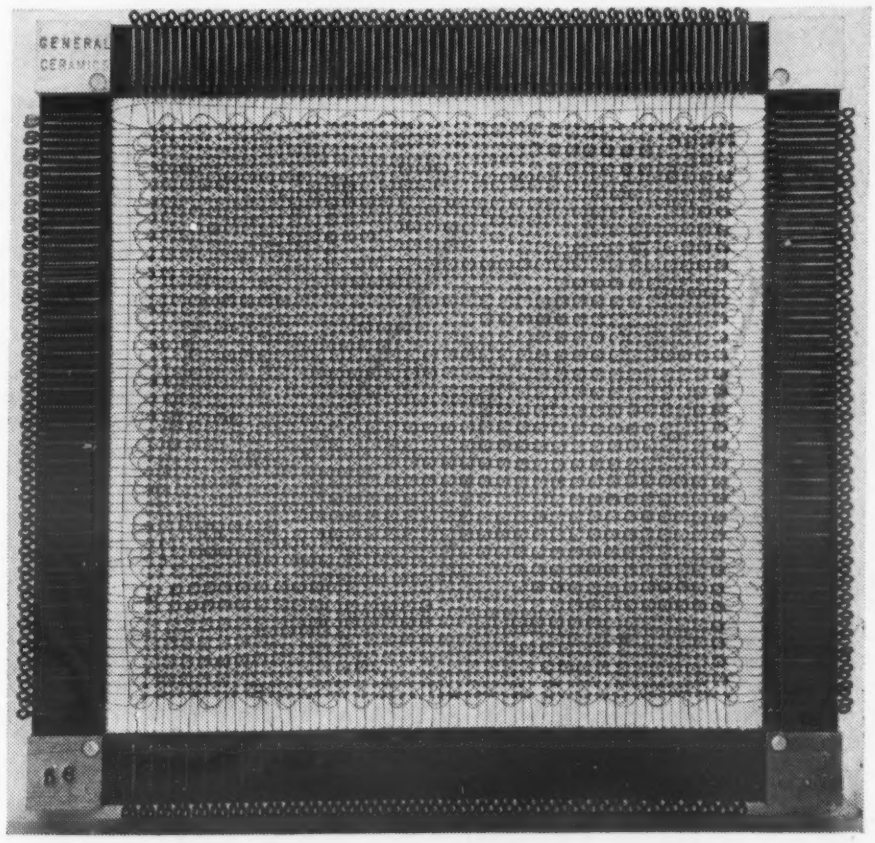

FIGURE 2

Ferrites are widely used as memories for computers. This memory matrix is commercially available and widely used in present and planned computers. The material was developed in a Signal Corps Program.

ters are beginning to play an important role in the battle to expand the number of usable channels of communication in our limited frequency spectrum. The device provides a new standard of stability and selectivity. Crystal filter units are now being produced in quantity to operate at frequencies where full advantage may be derived from their unique characteristics.

Another application of piezoelectric resonance was made several years ago when this effect was explored to see if very simple I-F filters for communications receivers could be made using certain new piezoelectric ceramic materials consisting mainly of barium titanate. Although the characteristic behaviour of these materials was known, the suggested application as substitutes for I-F transformers was relatively unexploited. A laboratory program initiated with an industrial organization for development of a practical ceramic I-F filter proved quite successful; it was found possible to design a family of very simple ceramic bodies whose bandwidth and other characteristics could be adequately controlled for communication filter purposes. These units have now been designed for 455 kc and higher (up to 1 mc) using ceramic plates of about 0.2″ diameter. This extremely small size, the low cost and the simplicity of fabrication make this new component an excellent addition to the growing list of parts dimensionally and electrically suited for transistor circuitry. A striking point to be made is that, here again, research and development have been able to use a simple *material* to perform the function that formerly required a combination of several parts to perform; a small disc of ceramic now does the job of 2 coils, 2 tuning cores, 2 capacitors, and 2 resistors . . . a decided step toward the simplification of our electronics for tomorrow. (See Figure 3.)

Quartz Crystal Units

The development of quartz crystal units for frequency control and for precision filters has had a history considerably different from that of any other of the common components used in electronic equipment, such as resistors or capacitors. This has been due principally to the complexity of this particular component. It is complex because, being an electromechanical resonator, it has had to receive the attention of both the electrical engineer and the physicist.

Between 1940 and 1950 the technology of producing crystal units for military communication equipment was recognized as of the greatest importance. With the heavy demand to meet military requirements, a concentrated effort was made to seek new methods and theories to improve existing quartz crystal units. This effort is continuing, as it must, to keep pace with requirements. The general purpose 0.02 percent tolerance crystal of World War II has become 0.005 percent, and units are now available for frequencies to 125 mc. The high accuracy and precision of these frequency control devices in adverse environmental surroundings provide the increased capabilities so necessary for the modern mobile army. And they have been assigned an important role in the missile and satellite programs, too. The success of the satellite transmitters is due in no small measure to the design effort that went into a crystal unit that would operate under the rigorous environments of missile transportation.

Although a crystal unit is subject to aging, continuing research to correct this deficiency has paid off handsomely. During the war years a crystal frequency change of 100 to 200 parts per million in a year's time was not uncommon. Now our highest precision crystal will not change more than one-half part per million during the same period.

As precise as these devices have become, planned equipment designs require even greater accuracy and stability of the frequency determining element. Without doubt, the quartz crystal will present a continuing challenge to both engineer and physicist.

Relays

Relays and high speed switches represent another family of parts being used in increasingly large numbers in military electronic systems. Their application in equipments ranging from highly mobile field equipments to guided missiles has placed previously unheard of requirements on these switching devices. This constant pressure for improved military electronic systems has provided a powerful stimulus that has resulted in significant improvements in existing relays.

For instance, in keeping with the over-all trend toward miniaturization, general purpose relays have been reduced in volume by as much as 40 per cent while at the same time the current carrying capacities were

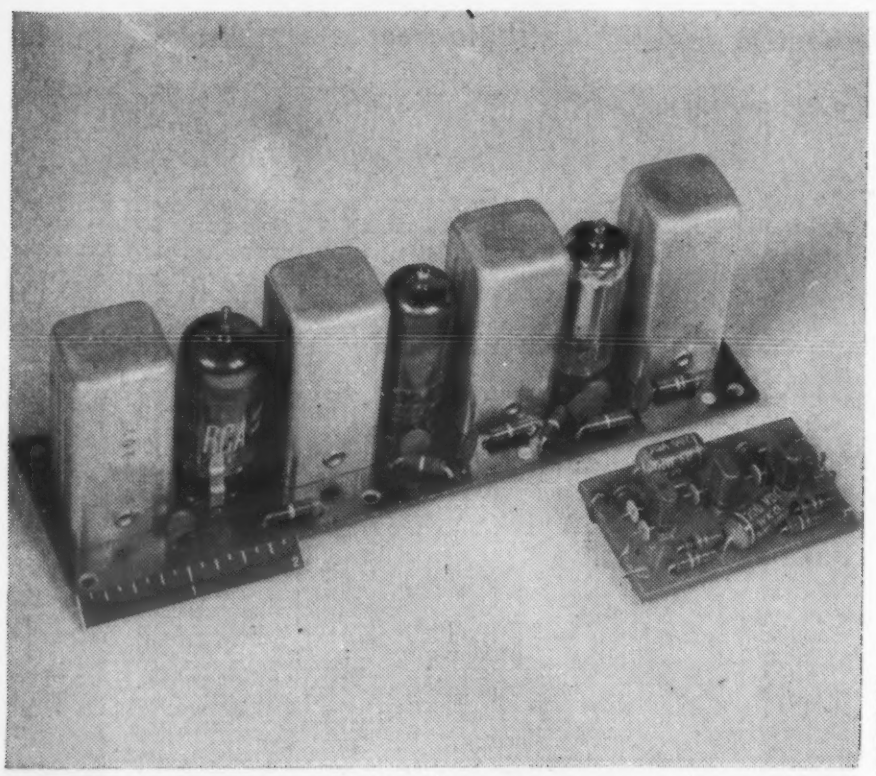

FIGURE 3

Piezoelectric ceramic IF filters will appear more and more in our future equipments due to the great saving in size and weight and increased performance. The transistorized IF strip at the right uses 455 kc encased ceramic resonators and is compared with a conventional tube IF strip.

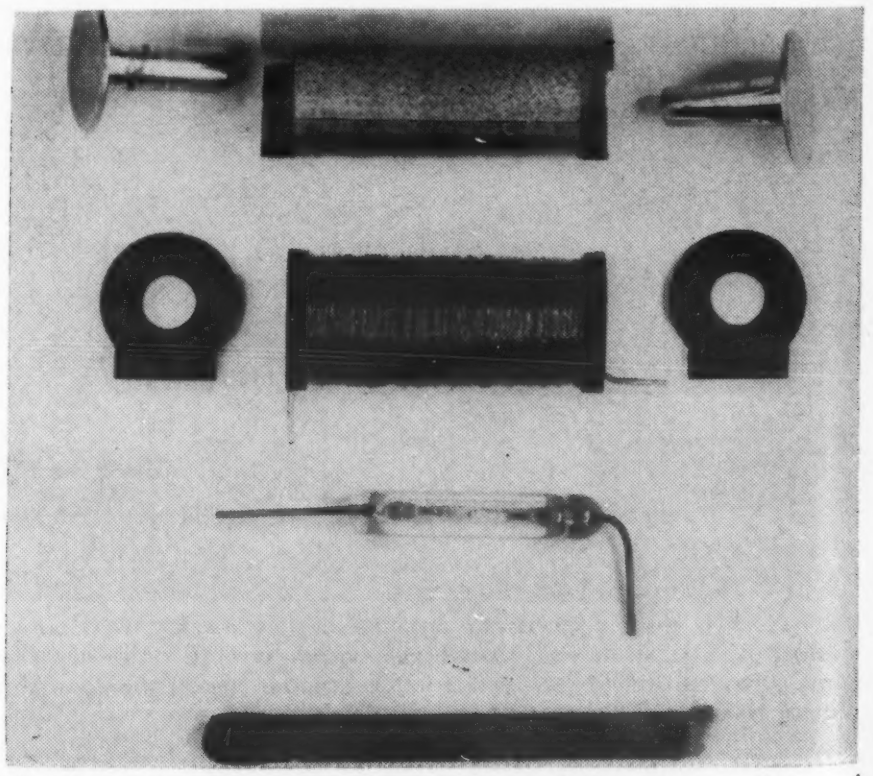

FIGURE 4

The reed relay is just one example of novel, new devices designed to give more reliable, better service in a smaller package. This same basic configuration will accommodate 6 switching contacts in one assembly. An ordinary match is shown at the bottom of the picture for size comparison.

increased.

Another example where improved design has paid big dividends is in the field of sensitive relays. This family of relays has been improved in sensitivity to the point where 50 milliwatts are now sufficient for operation over the entire range of field operating temperatures. Another important feature of this family of relays is that they can be interchanged with their obsolete counterparts with a minimum of difficulty.

Another outstanding development by the Army Signal Corps that has been applied to a host of relays is known as compartmentation. This technique involves the isolation of the relays' electrical contacts in hermetically sealed chambers. This novel design protects the contact surfaces from gradual contamination and thereby guards against malfunction in the field. Thus the technique of compartmentation has substantially increased the reliability and life of whole families of relays.

Where improvements in existing designs were not enough, whole new families of relays and high speed switches were developed. For instance, missile type components have been evolved to operate under severe environmental conditions of shock, acceleration, and temperature with no sacrifice in reliability or volume.

Another example, the still more recently developed glass-reed relay, fills a definite need for miniature relays to be used in conjunction with transistor and printed circuitry. Previously, design and maintenance characteristics of relays frequently dictated that they be placed remote to the circuit location where they were actually needed. Now, with the reed relay, which is about the size of a cylindrical capacitor, the switching or relay function is simply located in its logical location in the printed circuit. In addition the reed relay has achieved excellent reliability and long life characteristics by means of hermetically sealing the relay contacts in a small glass envelope. The contacts are magnetically actuated by a surrounding coil or actuating permanent magnet. This type of relay can be arranged to have up to 6 switching contacts within one assembly. Finally, the reed relay is readily adaptable to automatic machine production with its inherent advantage of low unit cost. (See Fig. 4.)

Recent research in the fields of semiconductors and ferromagnetics has provided new and potentially superior techniques for electronic control. Current development effort is being applied to the establishment of basic design and fabrication techniques for the generation of a family of integral, functional switching devices utilizing semiconductor elements which will be electronically and mechanically compatible with conventional relays. These devices promise extremely long life, high efficiency and high speed operation. These capabilities coupled with high volumetric efficiency and environmental stability will result in radically new classes of "relays" which will complement and supplement the high performance electro-magnetic relays in military equipment of the future. In fact, initial efforts have resulted in a transistorized switch having a 100 microwatt sensitivity and capable of switching approximately 50 watts of output power at operating speeds up to 2,000 cycles per second. A still more recent development makes use of ferromagnetic switching using logic function techniques. This approach has led to switching configurations having 500,000,000 cycle life expectancies, power handling capabilities of 5 watts, and excellent signal sensitivities. Continued exploitation in these areas will no doubt lead to other important high speed switching and relay devices.

Plastics

We do not always speak of small, individual components when we speak of electronic parts. For example, much effort has been devoted to the development of new structural materials such as plastics which have found innumerable applications in modern electronic equipments. Chief among these widespread applications is the utilization of plastics for antenna masts, radomes, and radar dishes. For antenna masts between 30 and 60 feet in height, reinforced fiberglass has fulfilled a definite need. For example, those plastic masts are electrically nonconducting which is an important requirement for some types of electronic equipments. Furthermore, the use of plastic releases critical aluminum and magnesium for more important applications. Prime among the attributes of plastic is the fact that it will not corrode even under the most punishing atmospheric conditions.

Reinforced plastic coated with a suitable reflecting material has also been used to fabricate parabolic radar antenna dishes. Here again, resistance to corrosion and light weight are the two outstanding features of these reflectors.

Since certain plastics are transparent to microwaves, they find an important application as radomes so necessary to protect sensitive microwave equipments from weather conditions without interfering with the operation of these equipments. These plastic radomes have been widely applied on ships, aircraft, and strategically located land-based microwave equipments.

Resistors

The common composition resistor is used by the millions in military electronic equipments. In simpler systems (of this sort) the composition type was adequate despite high temperature drifts, poor stability on long storage, and high noise levels. Now that system populations are growing, some requiring many thousands of parts, the individual complex equipments in such systems of necessity must be more uniform, more stable in performance, and more reliable. These inherent weaknesses of the compositions and other parts are becoming less tolerable in application as reliability requirements are tightened.

The Army has recently developed a new family of low cost, mass producible resistors of the deposited carbon type. These are projected as the ultimate replacements for most composition types in new Army equipments. A comparison of the stability performance of the composition and the new film types shows that at the end of only 500 hours of operation, about 75% of all compositions tested has changed by more than the 2 per cent limit established as the criterion. In contrast, after 2,000 hours of operation, only a fraction of the carbon film resistors failed to meet the criterion. This striking performance is further complemented by a five-fold improvement in temperature stability, a seven-fold improvement in voltage stability, and and a superior resistance to moisture.

Another recently developed family of resistors is the precision metal film resistors to replace most of the wire-wound resistors in future applications. A standard four megohm precision wire-wound resistor costs about $25.00 and uses three miles of strategic nickel-chromium wire. Millions of such resistors are used in Army equipments, with high total cost and substantial consumption of the metal alloy.

The new precision metal film resistors are due to replace most wire-wound resistors in electronic equipments. These new resistors are expected to cost sixty to ninety cents each in mass production. Of particular interest is the fact that the new resistor uses an almost infinitesimal fraction of the strategic alloy needed

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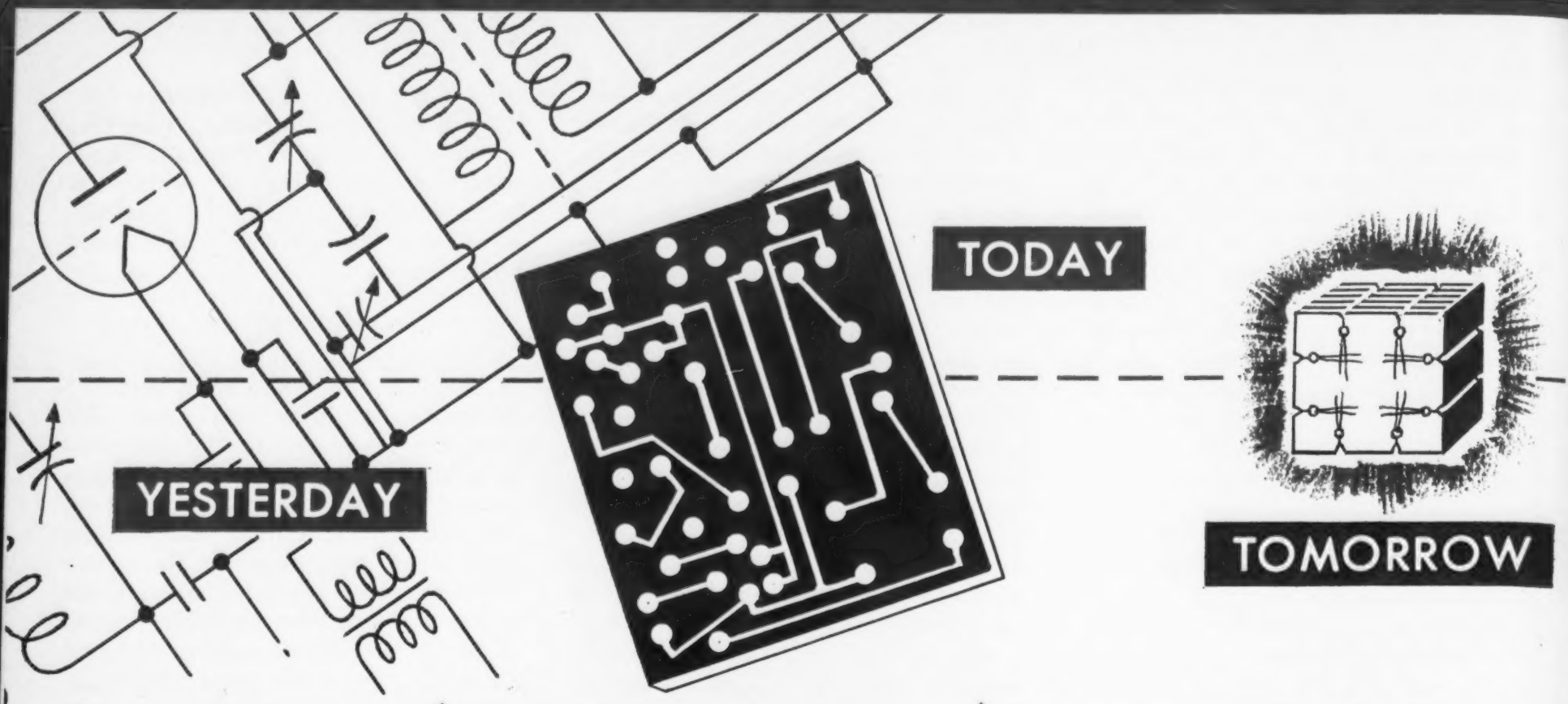

Miniature/Sub-miniature/Micro-miniature

MAKE it smaller . . . make it lighter . . . make it better. This unbending philosophy could be called the motto of today's military electronics designer.

In all military electronic equipments, size, weight, and reliability are critical elements of design. The first giant step toward more compact military electronics started in the early 1940's with the development of the "miniature" electronic vacuum tube to replace the larger octal types used by the billions in World War II. These new tubes were roughly one-half the size of their old counterparts and made possible the first major reduction in equipment size. Shortly thereafter, a second generation of equipments was born with the introduction of the "sub-miniature" vacuum tube, representing another ⅓ to ½ reduction in size of this particular circuit element.

At the same time that these new miniaturization levels in tubes were being reached, a complementary activity got underway on other associated electric parts — resistors, switches, capacitors, transformers, and so forth. As a result, new families of smaller parts slowly emerged to join the sub-miniature tube as the second generation of electronics came to maturity at the close of the 40's. With these sub-miniature tubes and scaled-down parts, it was possible around 1950 to design equipments with parts densities up to 8,000 parts per cubic foot. The Army's "Handie-Talkie" used in Korea was a good example of this new miniaturization capability. At this point, it was thought that the ultimate in the miniature art had been achieved and no further tremendous size reductions were envisioned for either parts or tubes. (See Figures 1 and 2.)

However, two major developments about 1950 — one, the "transistor" and the other, "solder-dipped printed wiring"—opened entirely new horizons for electronic development. The Signal Corps' solder-dipped printed wiring utilized the conventional high quality electronic parts but completely dispensed with hand wiring and hand soldering by use of a single solder-dip operation which joins the parts to so-called "printed conductor patterns." In this technique, the conventional parts are merely inserted into perforations in a plastic board on which a metallic pattern of the circuit has been formed. In a single dipping of the undersurface into a molten solder bath, all of the electric joints between parts and the circuit pattern are made at one time. Equipments so constructed today have their many circuits made individually on such printed circuit boards; these individual boards (called "modules") are provided with plug-in terminations so that they can be plugged into a common chassis as required to make up the complete equipment.

It is noteworthy that the American electronic industry has now mechanized many steps of this assembly process on its production lines. Printed circuit boards can be made by one machine, and automatically perforated at the proper places on another. Parts are then machine inserted into the proper holes on a continuous line, and finally, the circuit is automatically dip-soldered at the end of the line.

The tiny transistor with its capabilities of performing certain functions that previously only larger, bulkier vacuum tubes could accomplish was the second striking development that allowed an undreamed of plateau in sub-miniature construction to be achieved.

By applying the new tools of transistors and printed circuits, it has been possible to design the extremely compact helmet radio which is comparable to the Handie-Talkie in performance. The helmet radio is roughly half the size of the Handie-Talkie even though it uses almost 60 per cent more parts. The part density of the helmet radio is over 50,000 parts per cubic foot as compared to 8,000 in the Handie-Talkie. Its neat and orderly layout facilities maintenance and increases reliability. (See Fig. 3.)

Despite these substantial advantages we enjoy today in using the transistor and printed circuit, we are again approaching a new limit to size reduction—a limit beyond which only small incremental improvements could be foreseen with time.

Since pressure toward even smaller, more reliable, and lighter military equipments is a continuous one, a new concept of miniaturization called "micro-modules" was evolved as the construction approach to the Army's future electronic applications. The program based on this concept is aimed at reducing the size of future field equipments by a factor of at least 10 over today's best printed circuit designs.

The "micro-module" concept is

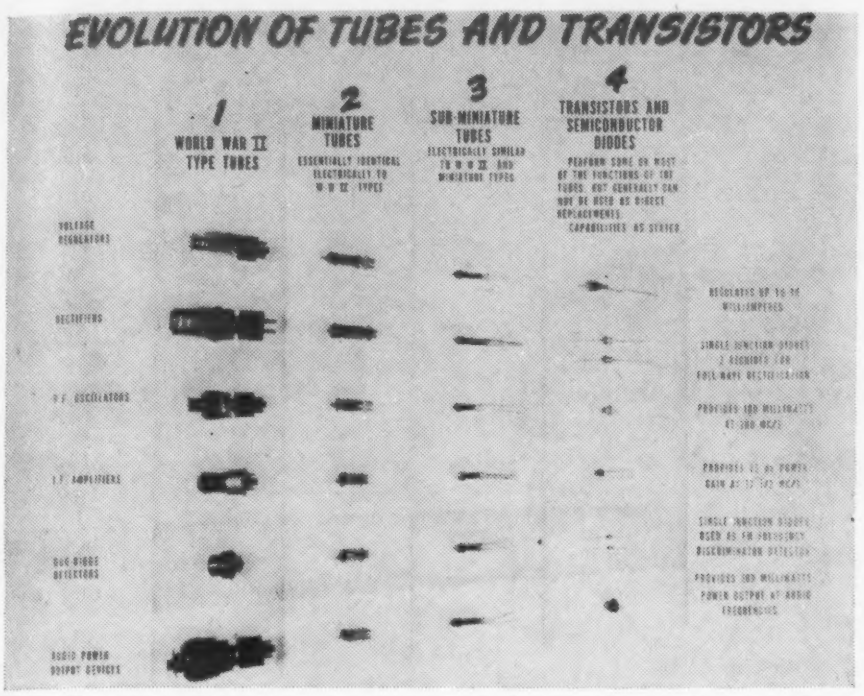

FIGURE 1

The effort to reduce the massiveness of electronics can be seen from the above photograph. Each group to the right represents a significant size reduction over the best components available previously.

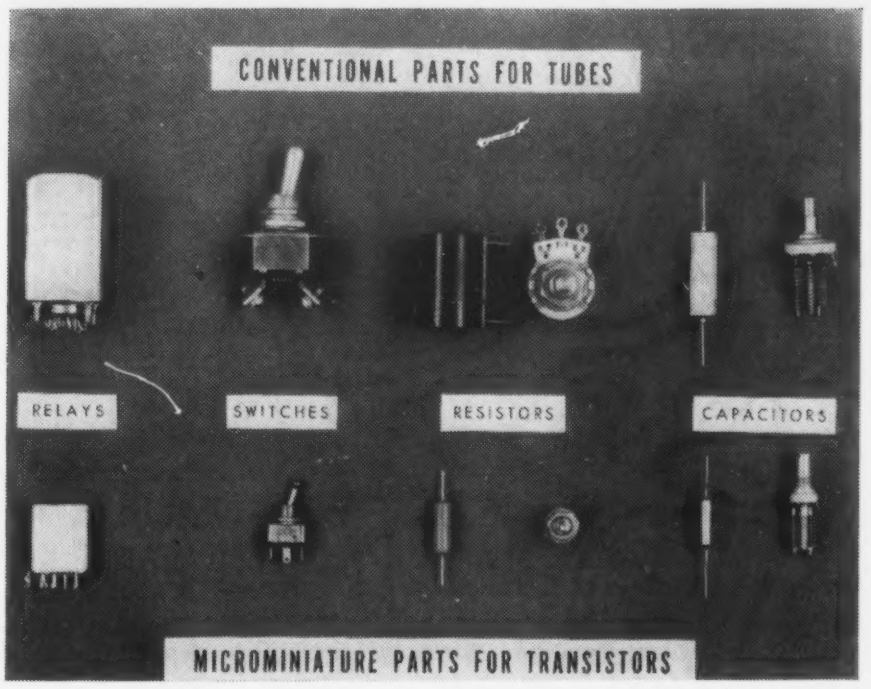

FIGURE 2

The size reductions of conventional electronic parts for transistor application are apparent. In some cases parts were reduced 6 times in volume, and in all cases the microminiature parts performed equal to, or better than, their larger equivalents.

based on the use of a common shape for all of the electronic parts and the method of their interconnection. In Fig. 4, four conventional parts of a simple network have been made in the same flat shape called "wafers" which are then stacked one on top of another and interconnected with side wires to form the micro-module assembly. Striking reduction in size is achieved using these flat shaped parts and just one protective covering over these parts instead of providing individual wasteful insulation in each part. By utilizing this form of micro-module construction, the part density has been increased from 75,000 parts to over 700,000 parts per cubic foot. The wasted space between parts in a conventional printed wiring construction has been virtually eliminated; the new parts are separated from each other by only the thickness of the ceramic wafer—1/100 of an inch. The Signal Corps is using this approach in its forward look to equipments for tomorrow's Army. Army electronic parts are now being redesigned in the shape of thin wafers, three-tenths inches square.

To illustrate the potentialities of this micro-miniature system, a complete five-transistor broadcast radio set (shown at the bottom of Fig. 4) has been constructed using five micro-module assemblies stacked in a space of about three inches near the center. A rod antenna is housed in the black front portion; the two white rings are used to tune the set. Small batteries are located near the other end where the earpiece connector is located. As a comparison, this fountain pen superhetrodyne radio receiver is comparable in performance to a standard five-transistor broadcast set.

The advantages of the micro-module concept do not stop with space and weight savings alone—a new and very desirable maintenance operation can be effected. Maintenance in this new electronics would be a matter of simply replacing one defective micro-module out of, say, ten total in a radio receiver, instead of requiring skilled technical labor to find one bad electronic part out of 200. Thus, when an equipment goes bad the defective module can be quickly located by checking a few test points; a new module is simply plugged in as a replacement, and the unsatisfactory one is discarded much like a defective vacuum tube is discarded today. Using this micro-module plug-in concept, repair personnel will need only a few weeks training on relatively simple testing techniques. In addition, the uniformly shaped electronic parts lend themselves ideally to handling by

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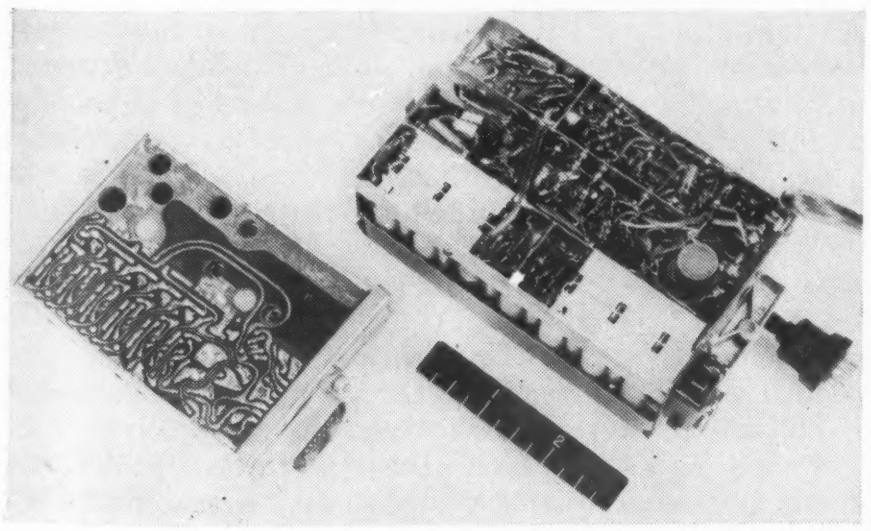


FIGURE 3

On the right is the Army's Handie-Talkie, which represents the zenith of miniature construction, using conventional wiring and subminiature tubes. This radio has a density of 8,000 parts per cubic foot. On the left is the compact Helmet Radio which utilized the transistor and printed circuits. This construction technique resulted in a density of 50,000 parts per cubic foot.

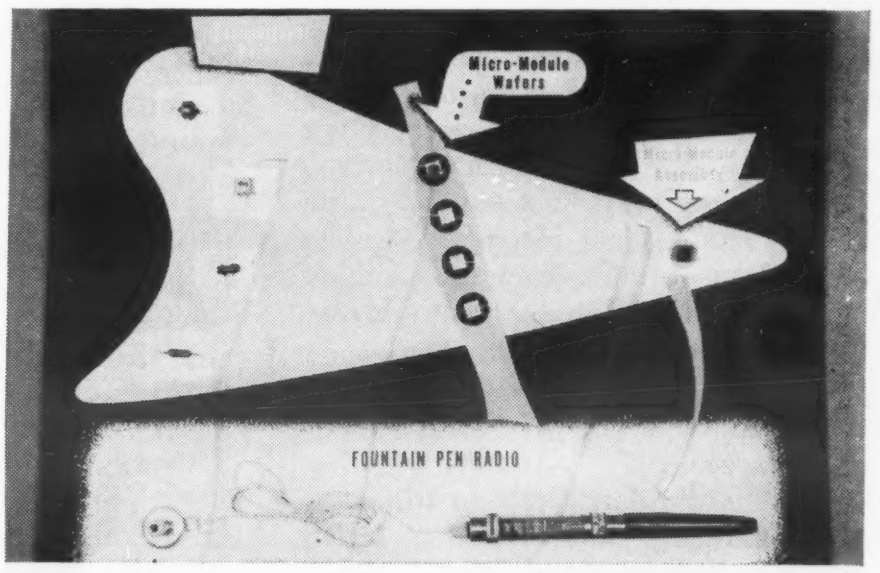
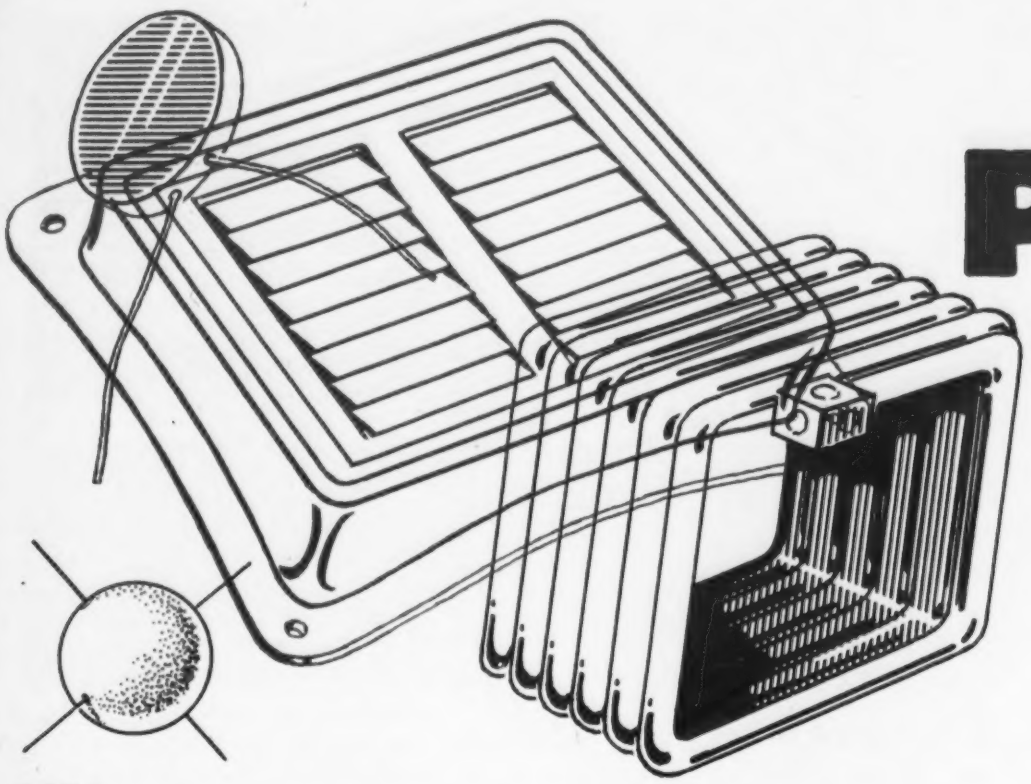
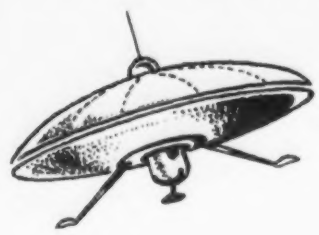


FIGURE 4

Conventional miniature circuit components consisting of a coil, transister, capacitor, and a resistor are shown on the left. In the center are the same circuit functions mounted on the Army's micro-module wafers. On the extreme right the micro-module wafers have been stacked and interconnected to form a micro-module assembly. Five of the micro-module assemblies are contained in the Fountain Pen radio shown at the bottom. This Fountain Pen radio gives performance equal to a commercial 5 transistor portable radio.



POWER
For the Future



WANTED!! An energy source capable of supplying electrical power in the kilowatt range, having no weight, no size, unlimited capacity, endless shelf storage capabilities, temperature and climatic immunity, no maintenance requirements, shock resistance, instantaneous activation capabilities, low cost, and so forth.

Obviously, this is the ideal energy supply. Yet, advanced information shows that power capabilities in the kilowatt range from a reliable source of about one cubic foot will be required for missile and satellite applications beginning in 1961.

Let us take a look at the power requirements of our present missiles and satellites and see how they are being met, as well as what kind of research and development work is being done to insure that the cubic foot of power described above will be available when needed.

Missiles

The most important characteristic of a missile electrical power supply is that it must provide a great surge of energy for a short time interval, usually ranging from seconds to minutes. This torrent of energy, which, in a typical defense missile ranges from 200 watts to 6,000 watts for an average period of 7 minutes, is essential for three basic missile functions.

They are:

1. The guidance system which includes radar beacons, seeker systems, stabilization equipment, etc.
2. The warhead and associated fusing elements.
3. The control functions which include servo, hydraulic, and fueling operations.

Furthermore, other essential characteristics such as reliability, minimum weight and volume, ease of maintenance, accurate voltage regulation, environmental stability, and instantaneous activation capabilities are of paramount importance in any missile power supply. (See Figure 1.)

In developing a power source for missiles, the common lead-acid storage battery similar to the one in your automobile was discarded because of its excessive weight, relatively poor stand-by capabilities, and fairly high internal resistance.

Fortunately, another type of high discharge energy source has been developed—the sintered plate nickel cadmium battery. This battery has found wide application in today's missiles because it has superior low temperature performance and an excellent high discharge rate when compared to the lead-acid storage battery. The nickel-cadmium battery, however, has certain characteristics which make it far from the ultimate for missile use. These include continuous float-charging, testing and maintenance to keep it fully charged and ready for instant use. For these reasons another type of high-rate battery with still greater capacity per unit weight and volume has been developed. It utilizes the reserve type zinc-silver oxide electro-chemical system which can be designed with the additional capability of automatic activation so desirable in missile applications. This automatic activation is accomplished by withholding one essential ingredient, in this case the liquid electrolyte, until the energy of the battery is needed. The electrolyte is retained in a tube which can be wrapped around the cell. To activate the battery for its short but busy life, a small gas producing charge is electrically detonated at the fore end of the tube, and the liquid electrolyte is forced into the cell by the gas pressure. In the unactivated condition the shelf life of this zinc-silver oxide battery is unlimited, yet it can be activated to full charge in less than one second. This battery is ideally suited for air defense missiles which must stand idle for a long period of time —perhaps indefinitely—and yet be ready to deliver power within one second after activation. If this missile is guarding an American city, there can be no misfirings on a cold morning. (See Figure 2.)

Satellites

Contrasted to the "rush" of energy a missile battery must supply in a short time is the "trickle" of power over a long period of time necessary for satellites. Present capabilities are somewhat limited and up to now have been in the range of several watts. In fact, the limited availability of power is the chief deterrent to full military utilization of a satellite. However, satellite electrical supplies capable of delivering 100 watts and more should be available in 3 years. It is primarily for satellites that the demand for power in the kilowatt range in a small lightweight package must be met.

This satellite power system must supply energy for four basic satellite functions and should ideally last for years. They are: data acquisition, storage, transmission, and control signal reception.

Besides providing energy for the above functions, the satellite energy source must be light but rugged, have an indifference to temperature extremes, and above all be reliable.

Zinc-mercuric oxide cells are being used in some of the present satellite

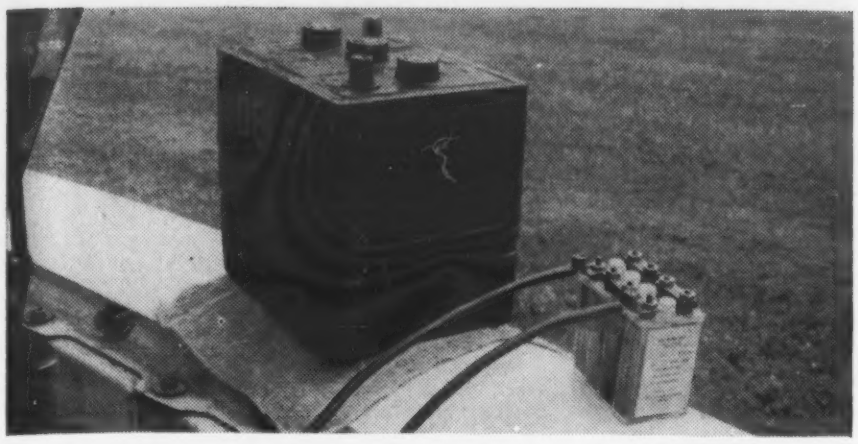


FIGURE 1

The standard 6 volt automobile battery shown on the left drew 1380 watts peak starting the automobile. The small zinc-silver oxide cells on the right illustrate the size reductions possible as a result of improved batteries. The small zinc-silver oxide battery started the car a total of 25 times in two minutes with no apparent tiring.

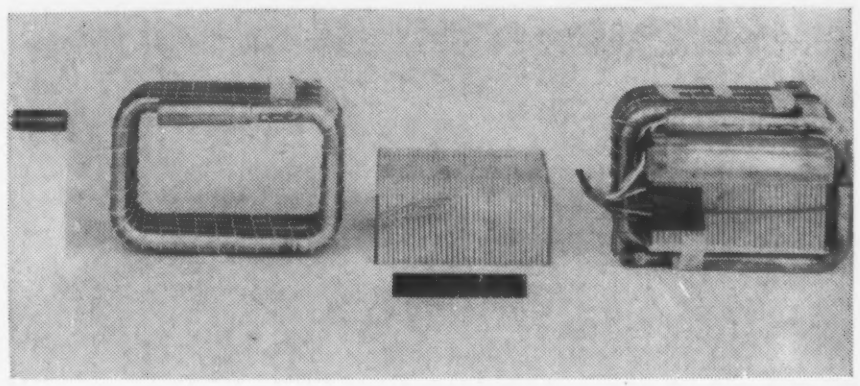


FIGURE 2

This automatically activated missile type zinc-silver oxide battery is composed of three major components. From left to right they are: the electrically detonated gas producing squib; the coils containing the liquid electrolyte; the zinc-silver oxide cells, and on the extreme right, the assembled zinc-silver oxide battery ready for activation. The squib is inside the fore end of the coils and the cells within the coils. The entire unit weighs ten pounds.

applications primarily because they have the highest capacity per unit weight and volume of any primary or dry cell system now in use. The mercury cell as it is sometimes called has two serious drawbacks that make the development of new power sources a must. They are: poor low temperature performance and extreme bulkiness and weight in high power configurations. For example, to provide an output of one kilowatt under typical satellite operating conditions for a period of one month, it would require the exorbitant volume of approximately 75 cubic feet of mercury cells.

The Vanguard Satellite, which is still orbiting, pioneered a new approach to space power requirements with the successful conversion of solar energy into electrical energy by means of small silicon solar energy converters. These devices, called solar cells, have unlimited lives and provide the necessary energy for the Vanguard's low power radio transmitter. (See Figure 3.)

The sun delivers about one watt of solar energy per square inch of exposed surface; however, the net efficiency of the Vanguard's solar cell system is about 7 per cent.

A vivid illustration of the improvements needed in satellite power systems is apparent upon examination of the Signal Corps' Cloud Cover Satellite. The instrumentation package of this satellite weighs approximately 12 pounds, and of this weight nearly 65 per cent was devoted to chemical batteries necessary to operate the high power radio transmitter. Contrasted to the unlimited lives of the solar cells, the chemical battery is designed to last only 3 weeks. Since up to 1,000 pounds of fuel may be required to place a single pound of instrumentation in orbit, a lighter, longer lasting satellite power supply would allow enormous savings in resources. The pay-off becomes evident when the cost of one year of continuous satellite electronic surveillance, using presently available energy systems, is compared to the improvement possibly expected in 3 to 5 years hence. Estimating between 20 to 25 days of service per battery, it would take approximately 18 satellite launchings a year to get 12 months of continuous satellite electronic surveillance. At an estimated cost of $10,000,000 per launching, the over-all cost for one year of continuous satellite electronic surveillance would be $180,000,000. On the other hand, with an improved power supply capable of providing a year's service, only one launching per year would be required at a cost of $10,000,000. The net saving of $170,000,000 per year for satellite surveillance is in itself a very powerful stimulant for improving satellite power supplies. Furthermore, it is envisioned that future satellites will carry more sophisticated data acquisition and transmission equipment such as television, surveillance, communications relay, and scientific instrumentation equipments that will necessarily dictate the development of compact power supplies to provide energy in the kilowatt range.

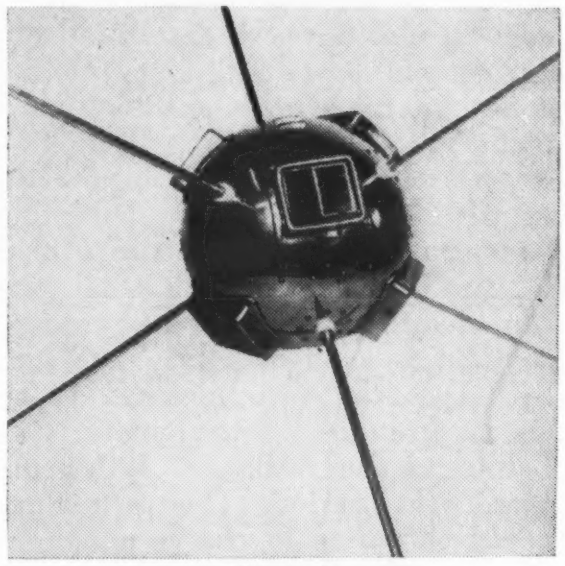


FIGURE 3

Five of the six solar cell clusters which power the Vanguard's transmitter are shown in this close-up. The solar cell clusters, which were built by the U. S. Army Signal Corps Laboratory, are equally spaced on the periphery of the satellite to insure that at least one cluster will always be directly exposed to solar rays.

New Concepts

Just where is the power for the military's various electrical needs of tomorrow going to come from, especially when such stringent performance is required?

One of the main hopes for this future energy is the nuclear battery. Although small nuclear batteries are now operative, their power output, which is measured in billionths of a watt, makes their application extremely limited. On the other extreme is the complex nuclear reactor which can deliver millions of watts. Somewhere in the nebulous middle ground between these two extremes lies the compact power source of the future. The amount of power available for either ground or airborne systems from a device of this nature depends essentially upon the amount of radioactive material used and the efficiency of the over-all system. In nuclear cells the heat developed by the radioactive material can be put to work in a number of ways. The most widely used method involves the use of a thermocouple to convert the heat energy to electrical energy. A thermocouple is basically a junction of two different metals which, when heated, produces an electrical current. The best present efficiencies of this type of system are in the order of 1 per cent on a 50 milliwatt unit, but recent developments indicate that the efficiency can be increased tenfold or better and the output can be extended to about 2 watts.

Another approach to the nuclear energy cell is called the thermionic emitter. In this device the nuclear source heats a shell surrounding it to a temperature sufficient to cause electrons to boil off the surface. These electrons are captured by a surrounding shell to create an electric current. Efficiencies as high as 8 per cent have

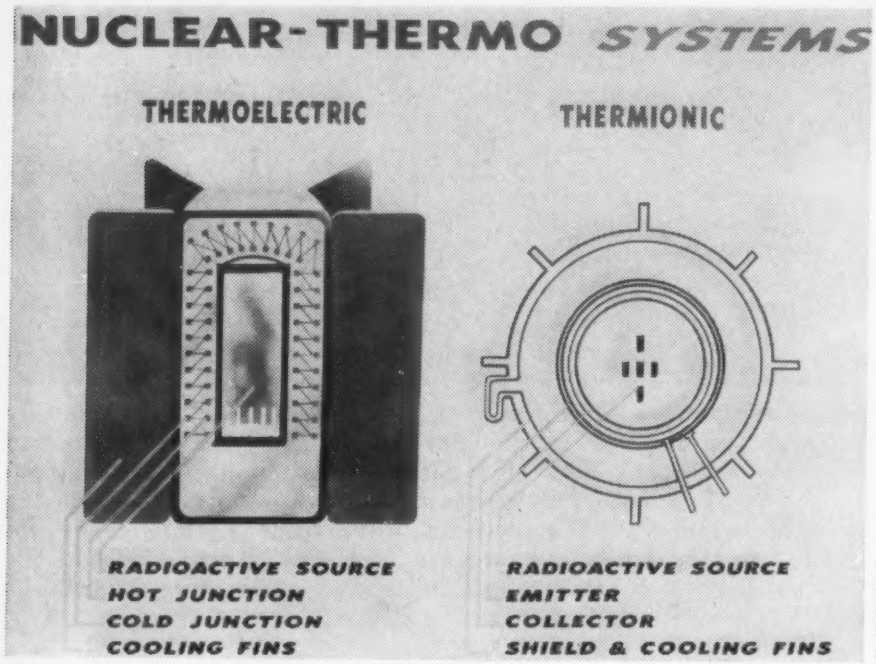


FIGURE 4

The thermoelectric cell on the left depends upon heat supplied by the nuclear source. This heat is converted to electrical energy by means of thermocouples. On the right is the thermionic cell in which the heat from the nuclear sources causes electrons to boil off the emitter. These electrons are captured by the surrounding collector to create an electric current. The practical lifetime may be varied from 90 days to 20 years.

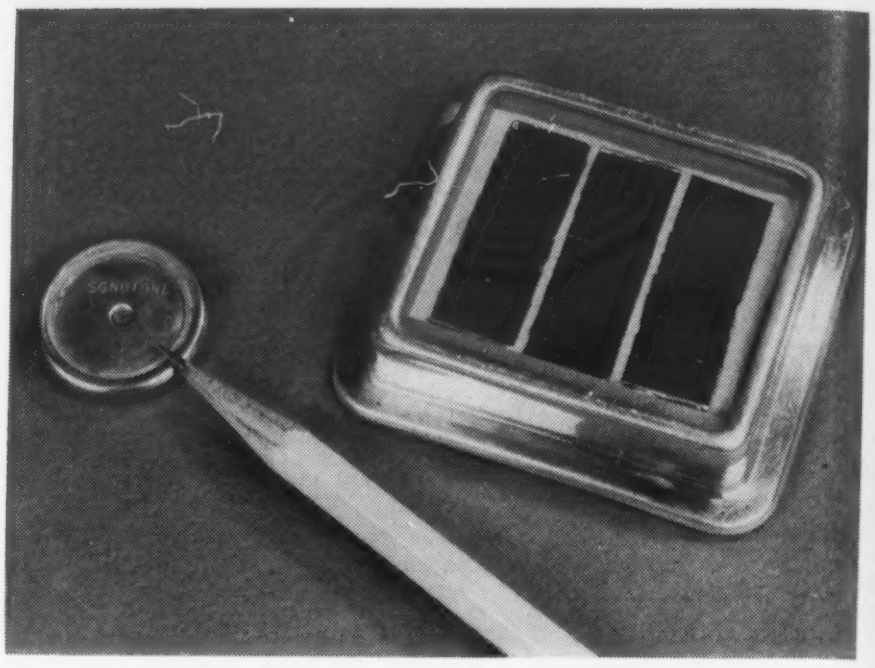


FIGURE 5

The solar cell on the right can be used to charge the nickel-cadmium cell on the left during light periods. During periods of no light the electronics can draw their energy from the nickel-cadmium cell.

• • • •

been obtained from this system, and efficiencies as high as 30 per cent are theoretically possible. This method of nuclear energy shows great promise and could well develop into the mainstay of future power supplies. (See Figure 4.)

A third type of electric power supply that shows exceptional promise makes use of a chemical-nuclear energy system. In this system the heat supplied by the nuclear source is converted to electrical energy by means of a chemical reactant. This reactant is constantly recycled to keep the process going. By using this conversion technique, efficiencies of 40 per cent or better are expected.

A very important advantage of all nuclear energy devices is that the useful lifetime can be varied from 90 days to 20 years by selecting the proper radioactive isotope. Such flexibility makes any of the nuclear batteries attractive devices for future energy systems.

The application of solar power for general use in military ground electronics also holds promise for the future. Since solar energy is practically free for the taking, it is in one sense an ideal source of energy and its applications are practically unlimited.

Due to their limited efficiencies our best practical solar-electric conversion devices can produce only about 1/10 watt per square inch of exposed surface. Several methods of improving the output of the solar cell clusters are under development. The most obvious of these is to improve the basic semiconductor cells so that their efficiency is higher. Secondly, to obtain more power, a greater surface area can be exposed to solar radiation to develop up to several hundred watts. Another approach to provide still greater power is to utilize a system of reflectors to focus the incident solar rays into a concentrated beam, thus providing more power from the solar cell clusters.

Besides its present successful use in satellite applications, solar devices can also be used in a number of ground signal equipments. For example, solar devices could provide unlimited life for surveillance devices placed in remote, sensitive areas as unattended electronic sentinels. Light triggered anti-personnel devices, target beacons, combat communication sets, and unattended relay stations could also utilize this sun power directly and effectively.

There is one obvious weakness in the use of solar activated devices—namely, that power is delivered only during sunlit periods. If a satellite goes into the earth's shadow, or if night falls on a ground application of a solar device, the electrical flow obviously stops. To overcome this handicap, a chemical storage system is used. For example, a solar cell can charge a storage battery while sunlight is available. When the sunlight fails, the electronics can derive energy from the storage battery. This battery can be recharged during the next light period. This procedure could be varied to charge a battery cumulatively during several light exposures and then use this battery for a very high power burst upon an electronic command signal from a controlling ground station. (See Fig. 5.)

General Purpose Power Supplies

The growing use and complexity of electronics in military field operations has frequently demanded orders of power beyond the capabilities of existing battery systems. However, with the advent of the transistor and its inherent small power consumption, battery powered equipment is again coming into its own. The most desirable advantages of batteries include relatively low cost, lack of moving parts, convenience, reliability, adaptability to size reduction, and mobility.

Such advantages coupled with the low power requirement of transistors make battery energy systems attractive for such diverse equipments as survival systems, radio packs, radar surveillance, infrared detection devices, wire communications, meteorological uses, mine and target detection, beacons, electronic countermeasures, and electric fuse systems.

The Leclanche cell typified by the well-known flashlight battery is still the most used cell in the military supply system. However, this does not perform well at arctic temperatures and is too large, occupying more than half the space and weight of portable electronic equipment. This proportion could easily increase as electronic components are further miniaturized.

To overcome some of these problems, a paper-lined electro-ore Leclanche cell was recently developed by the U. S. Army Signal Corps Research and Development Laboratory. This cell is a major step forward and has done much to help overcome the problems of shelf life storage and low temperature performance encountered in conventional dry cells. For example, this cell used as a flashlight

cell has an effective life of 400 hours as compared to the life of 150 hours available in the flashlight battery of a decade ago.

Another type of general purpose battery is the still more recently developed magnesium cell. This cell has an operating life of 500 hours as compared to the 150 hours of the flashlight cell previously mentioned. Furthermore, the newly developed cell has, for all practical purposes, eliminated the problem of shelf life storage for it has a 95 per cent retention of energy after two years of storage.

The recently developed transistorized power converter is another new and interesting approach to the power conversion problem. For many years, vibrators, rotary converters, thyratrons, cold cathode tubes, and so forth, were used to convert direct current from one voltage to another, but these methods have never achieved any high degree of efficiency particularly at low power levels. Furthermore, the use of moving parts in some of these devices in itself caused troublesome maintenance problems.

With the introduction of transistors, attempts were made to use them as electronic switches in converter circuits to achieve the long sought for static power converter. Initial attempts with early type transistors resulted in power outputs in the order of a few hundred milliwatts. The development of improved transistors made tremendous improvements possible in the transistorized power supply. In fact, present models are able to obtain up to 50 watts capacity while future models will be able to handle power outputs up to several thousand watts. The transistor power supply has several important advantages that make it a highly attractive energy conversion device. It is capable of high conversion efficiencies in the range of 87 per cent, noise free operation, and because it has no moving parts, low maintenance requirements. The converter is already beginning to replace vibrators, rotary convertors, and dynamotors in many military applications. For example, it has been successfully used in the orbiting *Explorer* satellite series to provide the required high voltage direct current for the cosmic ray equipment. In this equipment 4½ volts DC is stepped up to 700 volts DC. The transistor power supply will certainly find a variety of applications in future space vehicles, guided missiles, and ground electronics equipment.

Conclusion

The exacting demands of electronics equpiment have stimulated extensive progress in power supply facilities. This progress has resulted in smaller batteries that have high capacity per unit weight and volume as well as improved storage and low temperature characteristics. New energy sources and conversion devices such as solar cells, nuclear batteries, and transistorized power converters will play an increasingly more important role in supplying energy in future Army electronic applications. Rotating generators and mechanical vibrators in mobile and portable equipments (at least in the lower power classes) are in the first stages of obsolescence. In the next 10 years they should be replaced by nonradiating packages of stored energy. In the chemical battery field, it is hoped that the best features of the various electrical cells can be merged until a truly universal military battery is developed.

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New Parts for New Electronics

(*Continued from page* 11)

for the construction of the wire-wound resistor. Just an inch of the wire from the wire-wound unit would make well over one hundred of the new precision resistors with absolutely no compromise of reliability or performance. The point stressed in this comparison is the conservation of a critical material, just as important an engineering parameter in parts development as size and weight. Since such large numbers of the costly wire-wound resistors are produced each year for military use, the substitution of this low cost resistor reflects savings of millions of procurement dollars—a most satisfying return for the invested research and development dollar.

Capacitors

The accent on reliability of new parts is important since it will ultimately affect the reliability of all new equipments. Attainment of low failure rates for new parts is one of the most vital roles of the Army's development objectives. One of the prime reliability targets is electrical stability under varying temperatures. For example, temperature drift in standard mica capacitors causes detuning of circuits, reduces receiver sensitivity, requires frequent operator adjustment, and in critical operations can contribute to mission failure. Use of special temperature compensators means special selection of the mica units—an expedient at best, requiring undesirable stocking of specially selected parts. The Army's solution was the stacked glass capacitor in which a very uniform temperature coefficient meant simple compensation over wide temperature extremes. For large capacitors, the same glass is used but in very thin film form, about five- ten-thousandths of an inch thick which can be rolled with aluminum foil and fused to give a sealed capacitor that is impervious to moisture, has a very stable temperature characteristic, and the same good, high temperature performance of the stacked glass type. Upon development completion, rolled glass capacitors will find use in stable, low frequency filters, carrier oscillators, and other precision applications.

Let us look further at materials in action. A new capacitor for transistor applications uses extremely thin polystyrene film, about two-hundred millionths of an inch thick. The size reduction is 18 times that of the mica equivalent. What about the still smaller capacitors for the future? An additional ten-time size reduction using a novel electro-deposited film is anticipated. The quality compares to mica and the process appears to be production feasible. A still newer experimental technique uses a solid electrolyte of manganese dioxide with aluminum foil with an insulating spacer. Several square inches can be rolled into a one-eighth inch cylinder to get over one hundred micro-forads capacity. The present capability of twenty volts is being extended toward the fifty volt transistor goal. The advantages of excellent temperature stability, no electrolyte leakage, and low cost, noncritical materials point to an increasingly wide usage of these capacitors in the advanced electronic equipments which are now being planned.

Conclusion

We have tried to show by the above remarks that even in the area of basic electronic parts there can be something "new under the sun." Many of the accomplishments of our equipment designers over the past few years are directly attributable to the progress made in applying new materials, new configurations and, above all, new concepts to parts development.

The end is not in sight! Work going on in the nation's laboratories right now indicates whole new areas of electronic parts are right around the corner and each new part means a new or improved capability for our equipment and systems designers.

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SIMPLE telephone repeaters to massive radar transmitters . . . walkie-talkies to super weapon systems . . . almost every new technological tool being added to the Army's kit of defensive and retaliatory capabilities has the modern vacuum tube or its new cousin, the transistor, as the vital, active heart of operation. The growth of the electronic art has been closely tied to these electron devices, each new type introduced providing fresh capabilities for equipment and system exploitation. Since De Forest's simple triode in 1906, there has been a cascade of such tube types . . . tetrodes, pentodes, heptodes, klystrons, magnetrons, amplitrons, carcinotrons, thyratrons . . . and dozens of others, all dependent on control of the electron flow emanating from a heated cathode. The accumulated knowledge of electron physics gained in these tube developments, and the progressive better understanding of subatomic behavior of materials, sparked the invention of the Bell Telephone transistor in 1948; this tiny new device could amplify and oscillate without a heated cathode to provide electrons. In the decade since this first simple point contact transistor was introduced, there has been a steady progression of new types, varieties, and techniques . . . grown junctions, diffused base, surface barrier, alloy junction diffused base and others . . . a truly remarkable parallel in ten years of the first twenty-five years of the history of the tube.

Maser and Parametric Amplifiers

This eminently successful effort to control the basic electron is now being matched by still newer discoveries on control of the *atom* and *molecule* to perform the amplifying and oscillating functions. The research physicists have developed a new class of devices called MASERS* in which this kind of control can be exercised to give oscillators with exceptional frequency stabilities and amplifiers with extremely low internally generated noise. In fact, this unique capability of amplification without contributing self-generated noise permits the design of microwave receivers with advantages in sensitivity up to a hundred-fold over the conventional receivers we use today.

As an example of the improvements the solid-state MASER offers, consider the effects of its application to radar. If the conventional radar required 10,000,000 watts peak power and a dish antenna 250 feet in diameter to accomplish its mission, the MASER amplifier ideally would permit *one* of these advantages . . . reduction of the peak power requirements to 30,000 watts, or reduction of antenna size to 60 feet diameter. Thus mobile radars could effectively be employed where now only fixed installations can be used.

As an alternative, the MASER could increase the range *or* the sensitivity of any given radar. For example, for a given target size this new amplifier could extend the range from 3,000 miles to 12,000 miles, or for a given range it could reduce the size of the smallest detectable target from 150 square inches to 38 square inches. These advantages suggest direct applications to ICBM detection.

*Microwave Amplification by Stimulated Emission of Radiation.

Another device closely related to the solid-state MASER, and with similar low noise capabilities, is the parametric amplifier. This device is now being investigated as an alternate approach to provide future radio astronomy, radar, and surveillance systems with "supersensitive" detection capabilities approaching those of the MASER receiver systems. The parametric amplifier may be more practical for field use since, unlike the MASER, it does not require cooling to extremely low temperatures. The parallel exploitation and development of these new techniques will provide new super-sensitive devices necessary to give our field armies an expanded surveillance capability.

Atomic and Molecular Frequency Control

Aside from radar, the MASER phenomena should permit significant improvements in other electronic equipments. For instance, a missile-borne frequency control MASER of the ammonia gas type under development at the Fort Monmouth Laboratory has progressed to the point where preliminary tests are being made on it. This device uses the natural resonant frequency of excited ammonia molecules to provide a signal output at an extremely stable frequency. It is interesting to note that a satellite-borne MASER with its extreme frequency stability (on the order of one part in 10,000,000,000 . . . equivalent to a watch losing only one second in 300 years) would make it possible to confirm Einstein's general theory of relativity. (See Figure 1.)

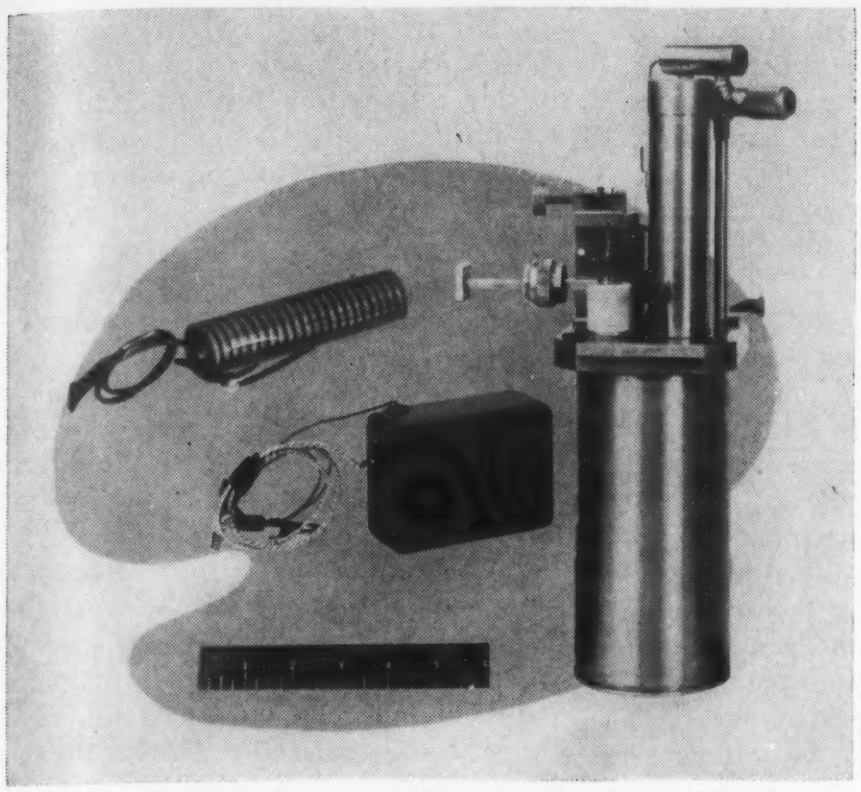

FIGURE 1

Frequency standards for very stable operation have evolved using completely new techniques. This ammonia beam Maser, designed for missile applications, features a short term frequency stability of about 1 part in 10^{10}. Other molecular and atomic resonance devices will greatly increase the capabilities of precision frequency standards over the next few years.

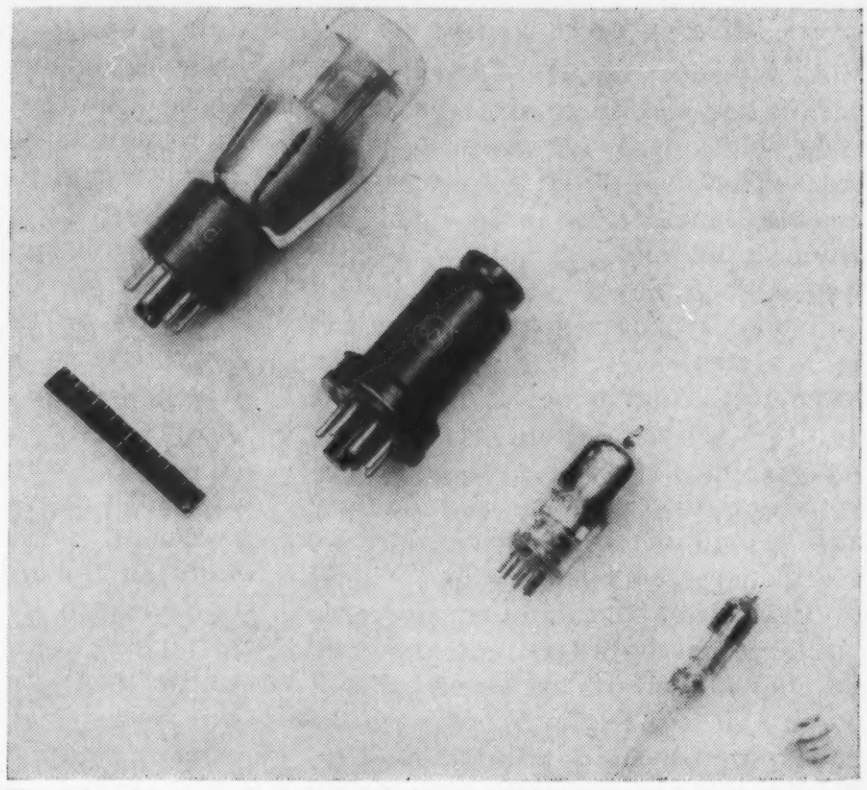

FIGURE 2

There has been an evolution of electron tubes over the past 25 years —each step providing increased capability. The tubes shown above include both commercial and military developments. In some cases tubes have been commercially developed and then evaluated and improved for military use such as the small ceramic tube by General Electric at lower right.

While the ammonia MASER has exceptionally good short term frequency stability (e.g., over a 0.1 second period), for maximum long term stability the atomic cesium beam standard is, at present, unsurpassed. Like the MASER, its center frequency is determined by fundamental laws of nature and thus will not change with time. This instrument, already in use by the military will have further applications in the future. Because of the accuracy and stability of frequency output, atomic standards will not only be useful to the launching of space platforms, but of immense value as electronic components and calibrators in navigation, position locating, and communication systems, as well as in the research laboratory. The work of Government scientists indicates, theoretically, that an atomic oscillator may show an accuracy of one part in one hundred billion, in comparison with the current national standard, radio station WWV, which is correct to one part in a hundred million. In other words, the atomic oscillator may well prove to be 1,000 times more accurate than the crystal.

Vacuum Tubes

In spite of the emphasis on semiconductors and other new phenomena as the golden keys to new accomplishments, vacuum tubes will continue to provide reliable and important electronic functions in our communications, surveillance and electronic countermeasure systems. The excellent quality of today's military type receiver tubes was no accident; prior to 1952, tubes for military use were primarily selected home-receiver types, and as such, their reliability was too often borderline. However, in 1952, under Signal Corps impetus, a new family of military type tubes, having common mechanical design characteristics, physical ruggedness, and a high degree of reliability was developed. This new family of tubes featured rugged construction, adaptability to automatic production, and small size. (See Figure 2.)

The present military supported program in the receiving tube field is now aimed at the next step . . . the conversion of the typical glass miniature and subminiature tubes to the still more rugged and smaller ceramic-metal construction. This will also provide tubes with a greater degree of reliability due to more strenuous processing techniques, superior mechanical properties, and the elimination of welds in fabrication. The elimination of the glass construction will also permit operation at much higher temperatures. For example, a ceramic material has been utilized in the construction of the thyratron shown in Fig. 3. The small ceramic device shown on the right performs the same circuit functions as the 12,000,000 peak watt thyratron of conventional construction on the left.

The tubes of tomorrow may be considerably different from those of today due to two promising developments currently underway in the Signal Corps. One of these is on the *field emission* phenomenon, an effect whereby a very high electrical field created at the surface of a metal may be used to literally *pull* electrons out of the metal without benefit of a cathode heater. Though still in the research stages, the possibilities of reducing this phenomenon to practical devices are intriguing . . . size and weight can be significantly reduced and need for filament power eliminated. Also, recent experiments at the U. S. Army Signal Research and Development Laboratory indicate that a self-sustained electron emission can be initiated from magnesium oxide films under certain conditions. The utilization of this emission in practical devices has received new impetus by recent development of a simple technique suitable for large scale production of reproducible, highly emissive magnesium oxide cathodes. The feasibility of employing such cathodes in amplifier output tubes has already been demonstrated. Model tubes were successfully used in an audio amplified unit which showed excellent, low noise music reproduction.* Use of the magnesium oxide cathode in other devices such as electron guns and secondary emission multipliers is now being studied.

Improvements in vacuum tubes are particularly being pressed in the microwave portion of the spectrum. Various microwave tubes are now under development striving for higher power capability in smaller sizes, lower noise levels, tunability over greater frequency ranges, and higher frequencies of operation.

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*Editor's Note: Treated more fully in article on page 50.

High Power Tubes

As indicated above, MASERS and parametric amplifiers are very promising solutions to the problem of increasing radar range by improving receiver sensitivity. There is still the other approach . . . namely, higher transmitting power . . . which will undoubtedly continue to be pressed as a system need in the future. In some cases, higher power will be the only possible solution. This *brute force* application of higher and higher powers to our radar, surveillance, and communication systems has focused increased attention to the field of high power tubes and considerable military and industrial research and development efforts are being expended in this connection. Some of the better known high power tubes resulting from past efforts include the magnetron, klystron, high power triodes, rectifiers, and hydrogen thyratrons. As an example of the power levels involved in our current programs: a 33,000,000 watt peak power hydrogen thyratron has already been developed by the Signal Research and Development Laboratory for use in high power search radars, and a thyratron to switch a 50,000,000 watt peak is currently under development.

The Signal Corps recognizes these high power tube objectives as vital for the Army's next generation of electronics and continues to maintain a vigorous research and development program in this technical area. Some of the Laboratory's other recent developments in this area include the highly efficient broad-band amplitron and the pulsed carcinotron; significant improvements have been made on some of the other established tube types such as the travelling wave tubes and pulsed klystron amplifier. The new and the improved tubes are now providing new systems and equipment capabilities for all of the Services.

Efforts on the high power microwave devices have been steadily directed toward higher and higher powers. At the present time, amplitrons, klystrons, and travelling wave tubes can deliver a megawatt of peak power at microwave frequencies. In addition, the unique amplitron (jointly developed by the Raytheon Manufacturing Company and the Signal Corps) has several other very significant features . . . an extremely high efficiency (approaching 65 per cent) and broad-band tuning characteristics. The new klystrons and travelling wave tubes, although they have somewhat lower efficiencies, have compensating gains which are several times higher than that of the amplitron; typically, 30, 40 or 50 decibels. Since some of the newer radar concepts require extremely broad operating frequency bandwidths, particular importance is attached, in this connection, to amplitrons and travelling wave tubes with their inherently broad bandwidths.

Considerable effort has also been expended on the development of high power electronically tunable driver tubes which, when used in conjunction with one of the broad-band high power transmitter tubes mentioned above, will provide extremely good frequency flexibility for future radars. Among the obvious advantages of such frequency flexibility are the ability of the radar to change frequency rapidly to avoid jamming and the ability to effect antenna scanning by purely electronic means rather than by the older mechanical methods.

The future poses even greater technical challenges to meet the demanding new field; these demands will require radically new principles and vastly improved mechanisms of electron device operations. For example, high power tubes *must be* designed to have extremely long life, be capable of withstanding the stringent environmental conditions of atomic warfare, be much more compact and lightweight, have greater bandwidths, and have higher efficiencies than anything in existence today. The Signal Corps Laboratory is intimately involved in the solutions to these problems on a continuous basis.

High Power Cables & Connectors

The recent advances in high power tubes and modulators for radar equipments have been complemented by Signal Corps development of high power pulse cables with unique low noise characteristics. These pulse cables operate at peak voltages up to 30,000 V, free from corona; transmit the power without undue heating; maintain reasonable pulse fidelity for lengths up to 300 feet, and do not radiate spurious noises which may interfere with nearby sensitive communication receivers. They are tough and rugged yet maintain flexibilty under low ambient temperatures even when subject to continuous flexing and bending.

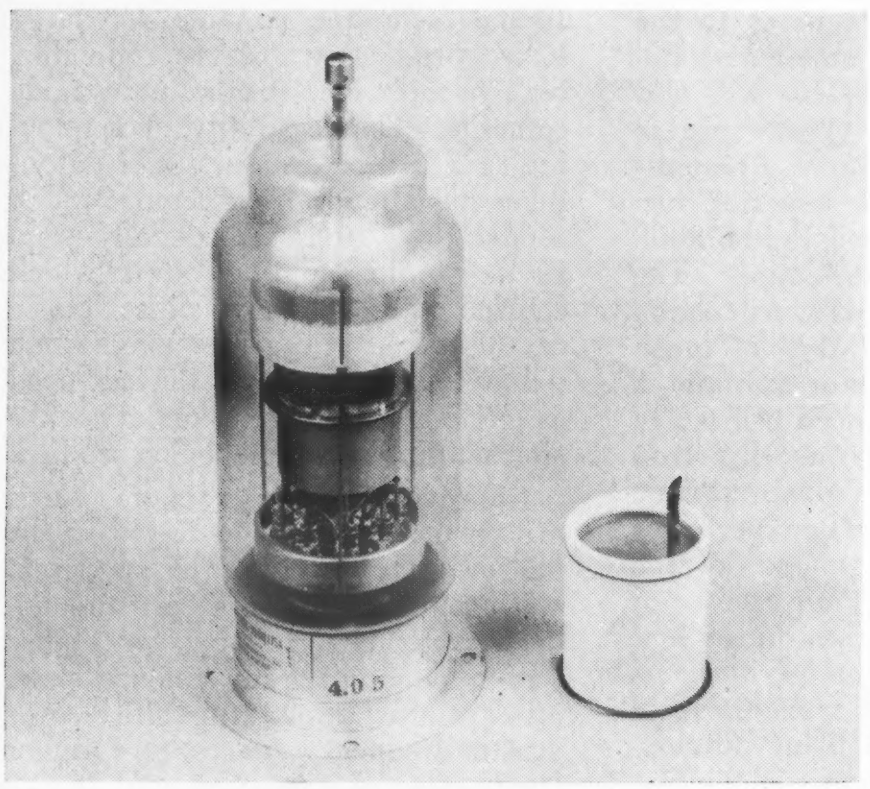

FIGURE 3

Ceramic tubes have increased the capability of tubes in the areas of reliability, high temperature operation, and size and weight. The ceramic tube shown on the right is equivalent to the conventional, glass 12,000,000 watt hydrogen thyratron.

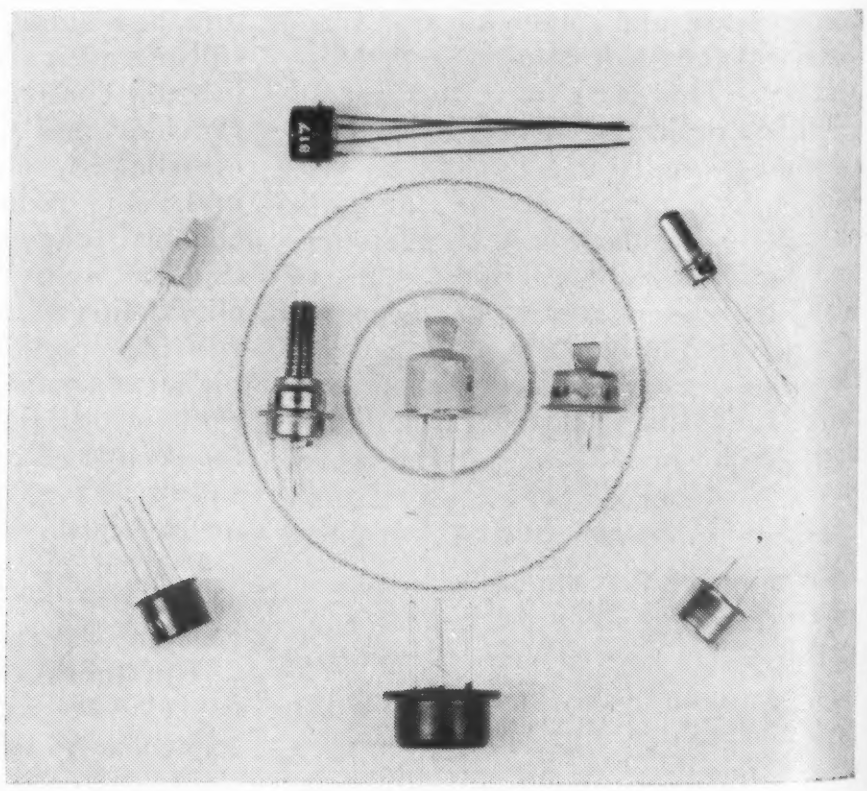

FIGURE 4

The inherent advantages of the transistor have had a tremendous impact on the electronic art. Seeing wide use in the latest military equipment, these transistors developed under Signal Corps contract have been used in satellite and communication equipment.

Achievement of megawatt cables and connectors such as these, required that new design methods and materials be used. For example, the cables have incorporated an additional copper braid in a novel "triaxial" construction. This design has been very effective in cutting down the very objectionable radiated "noise" associated with more conventional high power pulse cables.

Hand in hand with the development of these high power items, a new family of cable connectors has been developed. These "triaxial" cable terminations are available in a variety of shapes and are capable of handling up to 80,000,000 watts of peak power.

Transistors

The field of electronics has truly become one of extremes. One group of engineers will deal with parts that involve power levels up to megawatts; another group nearby may be working with other devices involving only micro-microwatts. Others, like in the transistor development activity, embrace more moderate power levels . . . up to several hundred watts.

Perhaps no other area of parts development is so intriguing from the point of view of possibilities and potential as the semiconductor field in which the transistor today is a star performer. The scientific principle of transistor action, first discovered in 1948, has added a new dimension to combat system electronics. In only one decade, transistors have become widely accepted, and military electronic systems have used the transistor and transistor-like devices in hundreds of equipments. The transistor is an active circuit element just like the vacuum tube; however, it is particularly useful in handling, processing, and controlling intelligence at relatively low power levels. The transistor is capable of extremely high efficiency of operation due to the lack of heater power required. Already the transistor is finding its way into many new military equipments. As new transistor capabilities are developed, the use of these devices increases at a rapid rate. For example, single computers using hundreds of thousands of transistors are in operation. Other large computer, telephone switching, and communications systems under development will extend the demand even further.

There are two reasons why transistors have not permeated all realms of military electronics. The first of these is that they are not, as yet, capable of handling the higher power and frequencies of many communications equipments. Secondly, the normal problems involved in developing production assembly techniques for semiconductor devices has contributed to the time lag.

To overcome the high-power, high-frequency barriers of transistors, the Signal Corps is pursuing a vigorous program related to the elimination of these operational limitations. Transistors capable of operation at 400 mc at a few milliwatts have already come out of this program, and higher power units operating at a frequency of 1 kc at 60 watts are actually in use in some of our advanced equipments—and this is just a beginning. The next few years should see devices operating well above 1,000 Mc/s at low power levels; power units will go into the kilowatt range at lower frequencies. Improvements in transistor materials and techniques are expected to provide devices with frequency-power characteristics suitable for the majority of the Army's electronic needs. Translated into specific hardware, this could mean: kilowatt transistorized converters, completely transistorized VHF transmitters and radars, miniaturized high power public address systems, expendable jammers, and other electronic equipment for forward area use.

The development of new transistors is not the only function of the Signal Corps program. Since very large quantities of these devices will be needed in the event of a future emergency, a program has been in effect for some time to increase the production capability and know-how for each new device as its development nears completion. (See Figure 4.)

For the longer look into the future, say 20 years hence, a major change is predicted in our concepts of parts and electronic functions. The individual part, as such, will gradually disappear, as solid-state *circuits* take over. For example, it is expected that new solid-state techniques employing radically new principles of operation will be developed to enable these devices to compete favorably with electron tubes in the generation and amplification in high microwave regions above 30,000 mc. Such circuits, furthermore, will be discrete "black boxes," complete within themselves, and will be replaceable as units rather than being repairable on a piece part basis as today. Also, inductance and capacitance effects can be established in semiconductors, and temperature compensated resistors using silicon are already on the market; these techniques suggest that practically all circuits eventually will be amenable to construction all within little crystals of selected materials. Solid-state devices are now being exploited as infrared detectors, photocapacitors, and as solar power converter sources. New families of semiconductor materials such as galium arsenide and silicon carbide are expected to give operational capabilities as high as 700°C; coupled to the capabilities for designing resistor, capacitor, and inductor functions into semiconductors, it is not inconceivable that complete circuits operating at these temperatures will ultimately come into being.

Conclusions

Electron devices have progressed from simple three-element tubes about 50 years ago to the complex MASERS of today. The power handling capabilities run the gamut from micro-watts to mega-watts in our newest military equipments. The further expansion of the arts and sciences of handling the electron for ultimate use in building our capabilities for preservation and for our everyday comfort appears limitless. The cycle of research, development, production, and, finally, equipment use must be nurtured at every step to keep the pipeline of progress filled at all times.

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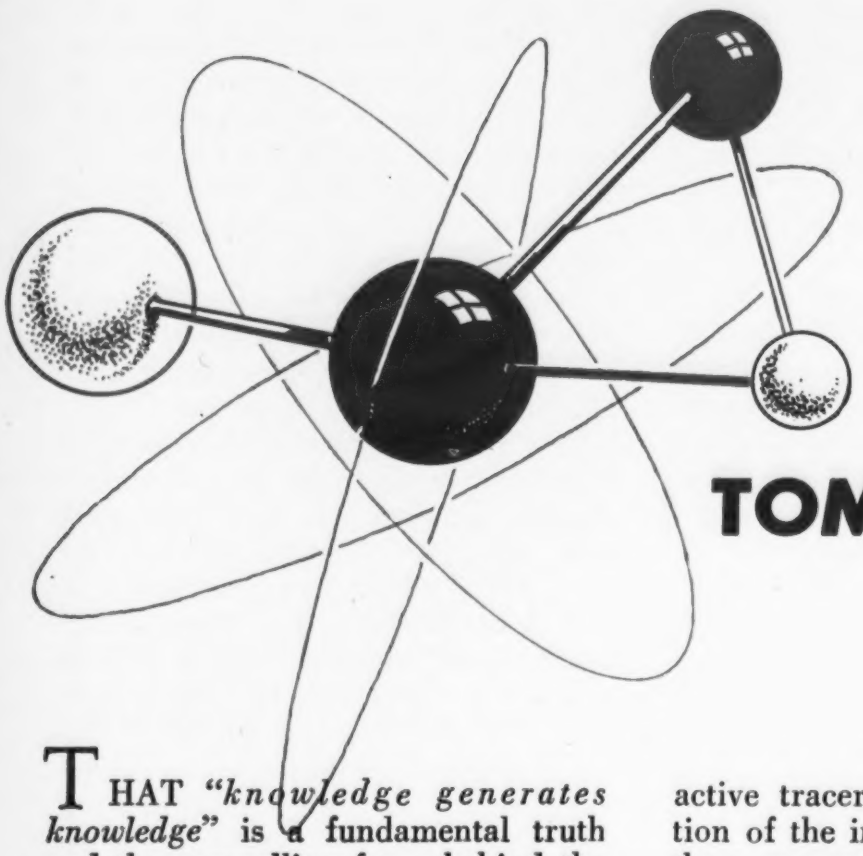

TODAY'S RESEARCH for TOMORROW'S COMPONENTS

THAT *"knowledge generates knowledge"* is a fundamental truth and the compelling force behind the Army's rigorous basic research program. The continuous searching, probing, and exploring within this activity of nature's materials and phenomena are aimed at providing us with new understanding of her processes. Knowledge . . . not devices and equipments . . . is the work product of this research and the key to new capabilities for technological progress and the superior electronics for the future.

Research Instrumentation & Techniques

Before undertaking any discussion of the *what* and *why* of research, it may be well to review the *how* . . . namely, the tools that the research scientist has at his disposal for his probing studies. We call this "research instrumentation" . . . that is, the basic tools that enable scientists to delve deeper and deeper into the secrets of nature. Fortunately, the materials researcher today has a vast array of ingenious techniques and equipments born of the efforts of the many researchers who have preceded him. The intelligent application of this modern instrumentation and the newer techniques it generates, is rapidly expanding the useful knowledge of material composition, structure, and the physical properties of matter . . . the first basic step toward meaningful improvement in our military capabilities.

To study the composition and its variations in crystalline structure deeper than the conventional thresholds of detection by chemical analysis, such techniques as X-rays, mass, and infrared spectroscopy are widely used today in conjunction with radioactive tracer analysis. An appreciation of the important role played by these research tools is indicated by the compositional control necessary in the production of high purity semiconductor material; impurities in these materials are in the order of a *few parts per billion* and must be rigidly controlled to provide the significant electrical and optical properties essential in semiconductor device applications.

Obviously, all such research instruments merely provide extensions of the human senses, which, in the final analysis, are the basic feeders of new information for digestion and rationalization within the human mind. Of these senses, vision has always been the most informative and anything which extends its range, automatically provides a new source of scientific knowledge. For example, the smallest objects which can be distinguished by the naked eye measure about 1/125 of an inch. To observe smaller objects, one resorts to optical systems which produce a magnified image. The optical microscope makes it possible to observe objects which are 2,000 times smaller than those distinguishable by the unaided eye. However, the researcher's electron microscope can magnify up to 285,000 times . . . that is, it can distinguish objects 1/35,000,000 of an inch . . . indeed a powerful extension to our sense of vision! (See Figure 1.)

In the field of semiconductor technology, so intimately related to our transistor capabilities, the electron microscope has been invaluable in revealing and identifying unsuspected structural impurities. By eliminating these undesirable contaminants, improved semiconductors have been produced.

In the fields of ferroelectrics, plastics, and magnetics, the electron microscope has provided valuable insight into the make-up and characteristics of these materials and showed the direction for improvement and enhancement of desired properties. It is also used extensively by the researcher today in *designing* new materials (essentially tailor-making the performance characteristics) . . . the so-called "molecular engineering", an intriguing capability in materials research.

Molecular Engineering

Molecular engineering of materials was motivated by the fundamental need to improve the working capabilities of materials in military environments. It has been with us in one form or another for many years, but only recently has it achieved status and recognition as a powerful tool for materials development. This kind of research in the atomic domain is concerned directly with property parameters of semiconductors, dielectrics, ferroelectrics, magnetics, and the other solid state materials that go to make up our electronic parts and devices. The knowledge of atoms and molecules and how they are arranged and bound together, the crystal structure of solids, the substitution of atoms and the resultant effects upon physical and chemical properties . . . all of these form the basis for this "tailoring" of materials to get improved or new electronic capabilities. From these studies it has been possible to establish rules to predict the occurrence of specific properties in varieties of substances. For example . . . ferrites and rare earth compounds are now revolutionizing microwave techniques by virtue of their unique microwave properties (see "New Parts for New Electronics"). For the families of new microwave devices, a great vari-

Figure 1

Research instrumentation provides the tools for man to increase his basic scientific knowledge. This electron microscope has extended, more than a hundredfold, the prior range of man's vision into the microscopic world. It can magnify objects 285,000 times to give a direct insight into the surface structure and behavior of materials.

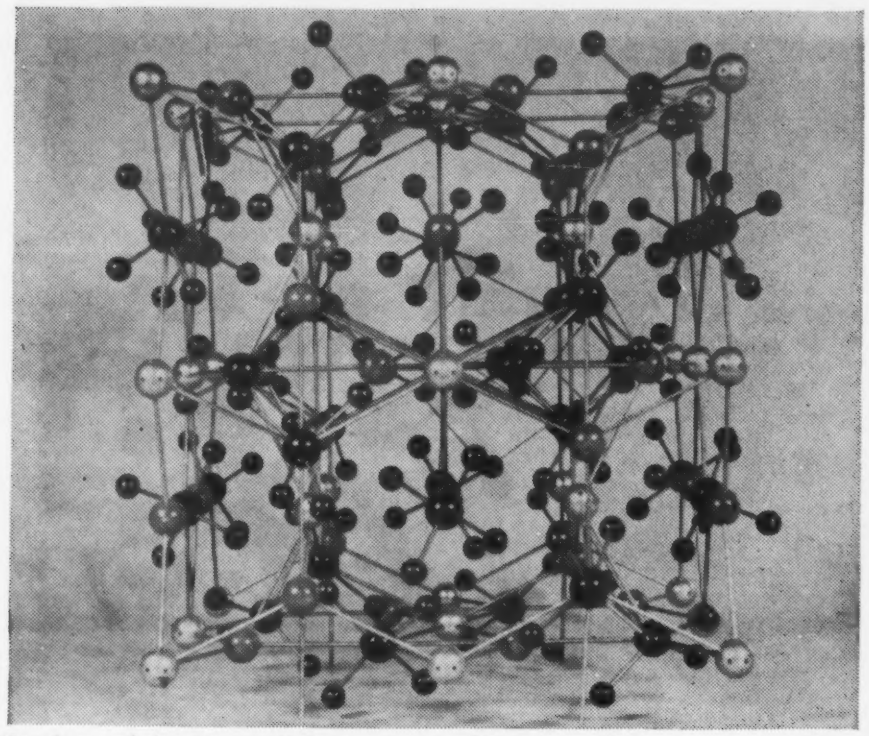

Figure 2

Studies of basic crystal structures (such as this garnet structure model) provide the basis for understanding and actual redesign of a material's performance. By controlled substitution of selected "ions" into crystal structures, it is possible to custom design or engineer the behavior of the material to suit a specific electronic purpose.

ety of magnetic properties over a wide range have been achieved by changing the amount and type of the substituted ions in the materials. Prediction rules have been worked out so that it is possible now to know beforehand how the basic parameters will change through the addition of varying amounts of certain ions. (See Figure 2.)

This kind of engineering on an atomic and molecular scale probably finds its best expression in the design of new plastic materials in which controlled atomic arrangements, substitutions, and sizes of the molecules are the parameters which determine toughness, elasticity, heat resistance, density, and so forth, of the material. The new materials being evolved today are seldom the result of a "chance mixture," but are the products of a deliberate and preconceived formulation.

Ultra Pure Materials

Absolute purity, in terms of composition and crystal perfection, is another research approach to new capabilities from our known materials. Germanium and silicon, for example . . . two of the important transistor semiconductors . . . can be controlled to the extent that their impurities are measured as *parts per billion*. As high as this purity appears, the fact remains that current studies at the Signal Corps Laboratory are being performed on materials of still higher purity. The objective of this continued effort is to get perfectly *pure crystals* whose properties at present can only be estimated. It is hoped that new and important phenomena useful to electronics can be found in such pure and perfect materials. As an example, consider a "whisker" of metal that can be induced to grow from iron under proper conditions. This whisker (found to be almost free of all impurities) has a tensile strength *30 times greater than common structural steel* and still more incredible, does *not rust*. Similar startling behavior may be found in the other materials now being explored.

To improve our understanding of these pure materials, new techniques are being developed by industrial and government laboratories to obtain ultra pure specimens. These techniques include the use of radioactive tracers and new methods of refining such as by electron bombardment and levitation melting. In the latter refining process, used in industrial operations, the metal is melted by induction heating while it is supported in space only by the interaction of magnetic fields. Some of these techniques, now widely used in industry, were developed by Signal Corps scientists. (See Fig. 3)

This particular area of exploratory research is expected to open unlimited new horizons using our common materials in their super-pure forms. This is in contrast to the previously discussed approaches where *new* materials are being designed and desired impurities are controlled to provide required properties.

Superpressure Research

Man-made diamonds, synthesized by the General Electric Company, are excellent examples of the fruits of exploration into *high-temperature* and *high-pressure* processing. Such investigations into super-pressures (over 500,000 pounds/sq. in.) and very high temperatures (over 3,000° C) represent still another research attack for the evolution of new properties and new materials. These experiments, in particular, provide valuable insight into the *high-temperature, high-pressure* properties of materials proposed for use in rocket, nuclear reactor, and high temperature electronic applications. The intriguing aspect of this research is that materials which do not exist in nature can be made by man. Considering the environment in which such materials are born, they are certain to find useful application wherever resistance to the punishment of extreme heat and pressure is required. The operation of such materials at the more moderate temperatures and pressures in which Army electronic devices operate, suggests that excellent operating efficiencies and stabilities may be realized well beyond what we are now getting from our known conventional materials. (See Figure 4.)

Such a *high-temperature, high-pressure* facility exists at the Signal Corps Laboratory and is being applied to the synthesis of new materials and new phases of our present materials. It is conceivable that these techniques can ultimately permit conversion of ammonia and hydrogen, for example, into metallic states . . . intriguing possibilities that will immediately find dozens of applications in power generation, weapons propulsion, and chemical production processes.

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• Requires no container for the Melt
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• No chemical reaction with container
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• Grow single crystals of silicon
• Opens new approach to ultra-pure metals

FIGURE 3

The floating zone technique, developed by Signal Corps research, permits the growth of a single crystal of silicon or other similar material from a polycrystalline metal ingot without use of a contaminating container. This technique is now widely used in industry.

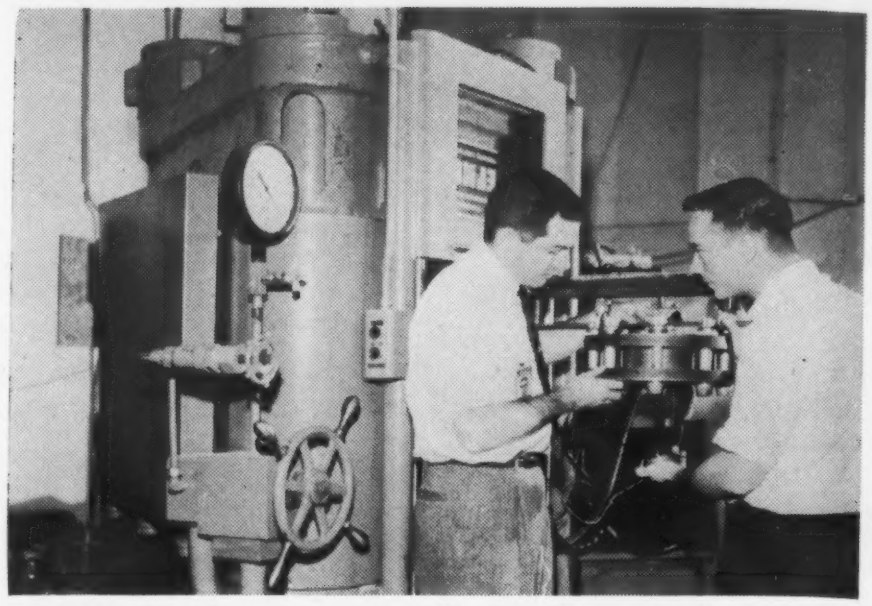

FIGURE 4

Right: this superpressure press, with a specially designed superpressure chamber, is capable of developing pressures equal to 2,000,000 pounds per square inch—enough to create man-made diamonds. The pressure created by the large hydraulic press on the left is concentrated in the small pressure chamber held by the man on the right yielding the tremendous pressures mentioned. This facility is being applied to the synthesis of new materials and newer forms of our present materials.

Radiation Effects on Electronic Parts

In the first few minutes after an atomic blast, reliable communications are especially essential for absolute command control of combat troops. However, certain apprehensions exist regarding the dependability of electronics when operating in such nuclear environments. It is known that radiation associated with tactical atomic weapons can damage certain electronic materials . . . for example, transistors may become ineffective, capacitors may fluctuate in value, and off-frequency operation of transmitters and receivers may occur as a result of changes in the electrical parameters of quartz crystal units when exposed to strong radiations. Thus, a missile that receives enough of a radiation dose to cause its electronics to falter even temporarily may go out of control and abort. If this sensitivity to radiation is high enough, a radio relay station, for example, could be silenced even though neither the men nor the equipment were physically damaged by blast.

One might immediately ask, "Why not shield the equipment from radiation?" The answer is that in most cases this would be totally impractical because of the gross bulk and extreme weight of present day shielding materials.

Research Program

As a positive step toward overcoming this radiation hazard, a far-sighted research program has been initiated at the Signal Corps Laboratory. This program consists of three mutually overlapping investigations, the first of which is seeking to determine "what" happens to electronic parts exposed to radiation. The second will analyze "why" these changes take place, and finally the third will seek to develop radiation resistance in these parts and devices using the knowledge accrued from the other portions of the program.

Once again, research performed *now* can provide the pay-off in reliable, radiation resistant electronics tomorrow. The program study under way now includes plastics, rubber, ceramics, metals, and other materials plus tubes of various constructions, transistors, diodes, crystal units, capacitors, resistors, and a dozen other components. These parts and materials are first subjected to controlled nuclear reactor exposures at the AEC's Los Alamos facilities to establish the general order of susceptibility to damage and then subjected to actual field testing in a nuclear blast environment to observe even momentary aberrations of performance.

These investigations of radiation effects have already shown that certain electronic materials are relatively immune to radiation and could be considered as preferred materials of construction; in others, changes due to radiation may be kept to a minimum by pre-irradiation. In other special situations, certain types of simple shielding can be effectively utilized. Accumulation of such information is essential to the ultimate development of a family of electronic parts that could properly operate in the nuclear radiation environment of the combat field.

Strategic & Critical Material Research

Half a century ago, orators discoursed on "our boundless forests, our limitless supplies of natural resources, which will last to the ends of time." But fifty years of dynamic advances in technology, increased civilian consumption of raw materials, and the gargantuan appetite of the military defense machine have made us think twice about the "plentiful natural resources."

Many of the materials needed for our electronic uses come from far-off places. There is cobalt, for instance, that must come from the Belgian Congo, columbite from Nigeria, corundum from South Africa, iridium from Canada, kyanite from British East Africa and India, quartz crystals from Brazil, and tungsten from Portugal and Bolivia. Military research and development are keenly sensitive to this situation and regard such materials as "strategic" and "critical" and strive to reduce or even eliminate our dependence on such items.

Consider, for example, the Signal Corps' newly developed precision metal resistors; these now use only a minute amount of a strategic nickel-chromium alloy instead of the miles of nickel-chromium heretofore used for a conventional wire-wound resistor.

Mica provides another example of research's contribution to alleviation of the materials problem. In 1937, the estimated United States consumption of sheet mica . . . an essential in communications equipment . . . was five million pounds. In 1950, consumption was up to fifteen million pounds of which only 4% was domestically produced. Most of this essential material had to be imported from India, Brazil, and Madagascar.

Research attacked the problem with two approaches . . . one, finding a process to make *man-made* mica . . . and two, finding a low cost, easily manufacturable domestic material as a *substitute* for the mica. Both approaches payed off . . . the Signal Corps, with the Bureau of Mines, developed a synthetic mica which, though limited in size of flakes, is commercially usable today and is finding growing applications as a natural mica replacement. A special highly leaded glass was the replacement material developed as the mica substitute, and millions of glass capacitors are used today in military communications equipment.

Even though tremendous strides have been made in the development of ultra-precision frequency control devices such as the *MASER* (mentioned in "Micro-watts to Mega-watts"), the Army's demand for quartz crystals for its ground and airborne communications equipments is still growing; the introduction of single sideband communications systems with their special bandwidth requirements has placed new demands on the performance of crystal oscillators and filters, in turn requiring still higher performance from the crystal elements. Unfortunately, high grade natural quartz suitable for such precision crystals is practically nonexistent in the United States.

Methods have been developed by the Signal Corps Laboratory for the production of suitable *synthetic quartz* using raw materials which are domestically available. As a result, quartz purer than the natural material can now be produced in increasing quantities. For production of crystals for its field communication equipments, the Army expects the crystal industry to fall back on the synthetic material in the event the foreign sources of quartz are cut off by any unforeseen situation.

Dozens of illustrations such as this can be cited, which collectively represent electronic progress not just for the Army alone but for the whole electronic industry. The vitreous enamel capacitor, solder-dipped printed wiring, the tantalum foil capacitor, the improved metal film resistors, the noncontaminating jacket for coaxial cables, the tiny quartz crystals, even some of the tubes in your TV set . . . these and other products of Signal Corps components research are commercially available today and widely used in military system and in commercial equipments. The fact that these are products of the Signal Corps' research and development is possibly incidental; it is more to the point to recognize that the military laboratories of all the Services are providing the stimulus and effective support for much of the electronic progress in the United States.

Conclusion

The researcher's creative thinking, his tools and his techniques for the creation of new materials and the understanding of basic phenomena are vital to our future technological progress . . . in electronics as well as in the other scientific fields. Unless this pool of new techniques and materials provided by basic research is kept full, our capability for development of new and better equipments must eventually be exhausted. Research is synonomous with progress . . . and to the military today, progress means survival.

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Miniature/Sub- and Micro

(*Continued from page* 13)

automatic machines in production with all the inherent advantages of low unit cost and the elimination of human errors in production and assembly.

The micro-module is destined to serve electronics across the board in all types of requirements just as the Army's printed circuits did about 10 years ago. For example, micro-modules are certain to find extensive application in missile systems. Since it takes up to 1,000 pounds of fuel to place one pound of satellite in orbit and 40 pounds of fuel to propel each pound of payload in a Jupiter rocket, any substantial reduction in the electronics deadweight had a tremendous return in improved capabilities. The capability of the micro-module to reduce the weight of missile and satellite electronics by a factor of ten underscores its positive future use in missile and satellite electronic applications.

Micro-modules are also destined to play an important role in conventional military aircraft. At present the size and weight of standard electronic equipment (compactly designed using printed circuits) limits the military system designer to only a few electronic aids in, say, a surveillance aircraft. By ingenious fitting, he can include his "must" electronics for radio navigation and control, a TV pickup and recorder, an automatic electronically operated photographic system, infrared detection system, and even a front seeing radar. But he is hard pressed to include such additional surveillance and countermeasure functions as: side-looking radar, nuclear detectors, radio relays, electronic jamming devices, and others needed for tactical use. However, there is no room for this additional tactical electronics without going to larger and vastly more expensive aircraft. Here again the solution is to make the electronics very much smaller, and to this end the micro-module with its ten times size reduction will contribute directly and effectively.

Another outstanding feature of the micro-module concept is its high degree of resistance to physical shock and vibration. This toughness is achieved as a result of the small mass of the module and the complete plastic encapsulation of the assembly. This plastic (resin) seal provides excellent protection against atmospheric moisture and climatic extremes, as well as providing the rigidity necessary for extreme reliability under conditions of high shock or vibration such as those found in missile applications. Sensitive circuit components such as transistors are hermetically sealed between ceramic wafers, completely protecting the tiny element from even its plastic coating.

The future application of micro-modules is not limited to purely military applications. Using the micro-module concept, bulky fixed computers requiring racks upon racks of conventional assemblies can be reduced to readily portable units. In the communications industry an experimental micro-miniature decoder for a million subscriber paging system is under development; this decoder occupies less volume than a package of ordinary cigarettes.

Conclusion

Stated simply, micro-modules promise to reduce the massiveness of the military's new electronics by a factor of ten, contribute superior performance and dependability because of the inherently superior shock and vibration resistance of these tiny aggregates, and reduce the growing economic burden of electronics by as much as 50 per cent. Through the throw-away simplified maintenance procedures, the micro-modules can slash maintenance expenses down to about one-fifth of their present figure. With presently planned schedules, the first significant impact of the micro-module will be felt in the Army's electronics within the next five years.

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some thoughts on the NASA program *

by **DR. HOMER J. STEWART**
Director
Office of Program Planning and Evaluation
National Aeronautics and Space Administration

* components—starting point for space economy

THE NATIONAL Aeronautics and Space Administration (NASA) came into existence formally on the 1st of October, 1958, with a dual responsibility for both aeronautics and space activities. It is my purpose in this article to discuss only the space phase.

The NASA activities in space encompass both research and development, not only in the various fields of application of space technology, but also in the basic rocket vehicle, guidance and communications aspects of the technology itself.

While NASA was born as an operating agency, it is not proper to think of its coming into existence with no foundation on which to build its space program. A great deal of preparatory work had gone on during the early part of 1958. In particular, many of the programs initiated by the Defense Department's Advanced Research Projects Agency (ARPA) were undertaken with the broad national interest in mind and with the view that they would be transferred to a civilian space agency when one became operative. The former National Advisory Committee for Aeronautics and ARPA personnel cooperated in the planning of these preliminary steps.

The space probes of the past few months and satellite launching efforts of last summer are examples of this cooperation. Although initiated within the Department of Defense, the programs were philosophically oriented toward the interests of the civil agency, carried out as a portion of the International Geophysical Year effort and transferred to NASA upon its activation.

One way of describing the NASA program in space is to think of a trihedron (a figure formed by three planes meeting in a point). The first side is supporting research which helps to establish a solid technological foundation for all phases of future activities. NASA has extensive resources in this area. Part is represented by our research centers, formerly NACA laboratories: Ames, near San Francisco; Langley, in Virginia, and Lewis, in Cleveland. This side has been further strengthened through the recent transfers of Project Vanguard from the Naval Research Laboratory and of the Jet Propulsion Laboratory from the Army.

The second side of the trihedron is the NASA program concerned with the scientific research in the environment of space. Our capacity to carry out these activities is necessarily limited to the interim vehicles which are readily available, including the Vanguard, the Thor-Able, the Juno II and more recently the Atlas. The most dramatic recent step in expanding the scope of this kind of activity is illustrated by the selection of McDonnell Aircraft Corp. as the source for the development of the space capsule to be used in Project Mercury. An active program of scientific experiments carrying on the work started during the IGY and in satellites and deep space probes will continue and will expand in scope as time goes on.

Completing the trihedron is the NASA program concerned with developing and testing technical equipment to greatly increase our capacity to do work in a free space environment. The initiation of a program aimed at developing a million pound thrust engine represents a firm step along the long path toward very large-scale programs in space, including the possibility of manned-flight to the moon and return. At periodic intervals in the future, we may expect announcements of similar development activities to indicate the rate at which our national capabilities are expanding.

One important question discussed frequently concerns that proportion of the national economy needed to carry out an active program in space research. At first glance, the costs appear prohibitive. We may recall, for example, that the Vanguard, with a take-off weight of about 22,000 pounds, has placed in orbit a small test payload of less than four pounds. The ratio is about 6000 to one. Even the 21-pound design payload for Vanguard corresponds to a ratio of about 1000 to one. The 18-pound payload of Explorer I, which was launched by Jupiter C, corresponds to a ratio of about 3000 to one. The most recent launching of a communications experiment by the Atlas ICBM has a corresponding ratio of about 1600 to one.

If these ratios were characteristic, then future space activities would indeed be costly. Even after considerable development, and taking into consideration the relative inexpensiveness of rocket propellants, the cost of rocket launching vehicles is something like $10 to $12 per pound. During the early experiments the cost is, of course, much higher but even at $10 per pound and a ratio of 1000 to

(*Continued on page* 29)

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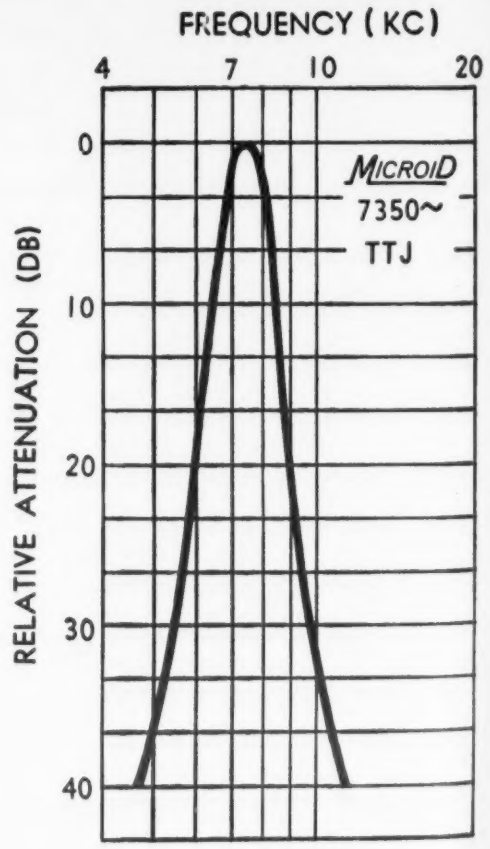

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(*Continued from page 27*)

one, the vehicle cost would be about $10,000 per pound of payload delivered into orbit. In addition to the direct costs of the vehicle, there are costs of launching, tracking and data handling which must be supported. In such circumstances, a 3000 pound payload, like Sputnik III, or the still larger payloads that will be required for any extensive manned space flight operation, would be extremely costly.

Fortunately, these numbers are not typical and do not represent the scale on which our planning must be based, even though they are correct for our present operations, which use interim launching equipment. If we design equipment specifically for space purposes, it appears that a ratio of 40 to one should be readily attainable and a ratio of 25 to one is consistent with our current state of knowledge. Under these circumstances, the cost of a vehicle to deliver a payload into orbit may be expected to be as low as $300 per pound. If we consider that the cost of high grade scientific and electronic equipment, which would constitute the major portion of the payloads, as well as added cost, is of the order of $100 to $1000 per pound, the delivery cost does not appear to be at all disproportionate.

These calculations not only indicate that the costs of a considerably expanded activity in space will not require a proportionate expansion in our budget, but also show that the large boosters developed for the U.S. military weapons programs have the capacity, if modified, to launch very substantial payloads into space. The modifications required are, in general, some strengthening of the structure and the development of suitably sized upper-stage rocket vehicles. In addition, the guidance and communication equipment must be tailored to suit the special needs of space missions. Here again, the *components* developed for use in the weapon programs provide a very good starting point. The needed changes are reasonably straight forward but cannot be done overnight, or even in a few months. If these changes are introduced, an IRBM has a potential orbital payload in excess of a ton and an ICBM has a potential payload of the order of four or five tons. The need for still larger equipment represented by the million pound thrust engine is obviously associated with the very difficult kinds of space operations which we hope to grow up to during the next decade.

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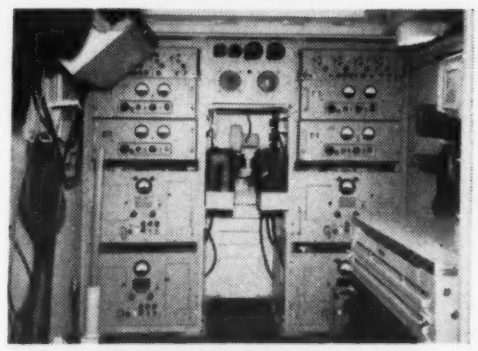
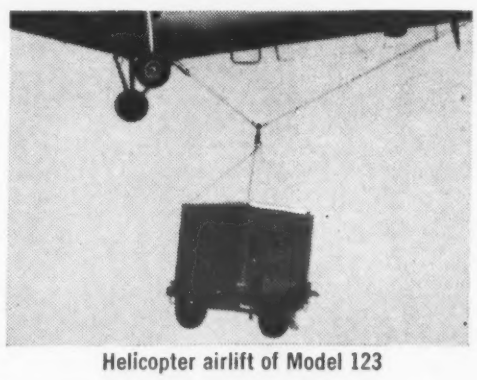


Typical Craig mobile electronic installation



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POSSIBILITY OR CAPABILITY?

by Col. Charles W. Gibbs
Signal Officer
US Army Air Defense Center
Fort Bliss, Texas

IN the science section of *Time* Magazine August 4, 1958, there appeared an article titled "A Use For The Moon." The article described an Army experimental radio teletype circuit between Benson, Arizona and Encino, New Mexico via the moon.

Research is always an essential step in technological progress of the Army. Each breakthrough in scientific progress is of course an historical occasion. An item like the one referred to above captures our imagination. It is quite obvious, for instance, that we are a step closer to long distance television as a result of these experiments.

What with Explorers zooming overhead and whirring computers performing mathematical miracles, it is easy for the general public to get confused between what is an operational reality today, and what is merely a milestone in scientific progress which may not be operational in the fields for maybe years from now. Constantly, the search goes on for new components, new products and new breakthroughs in the communications field. However, as important as this is to the state of the art, there is an immediate urge to accept the new and neglect the past.

Daily, some piece of hardware or technique is reported in the press as a "capability" when actually it may be little more than a possibility. This is particularly true in the fields of missiles, aviation and electronics. For example, the surface-to-air missile program of the Army has been a capability in being, in every sense of the word, for several years. Veteran missilemen return to Fort Bliss year after year for their annual service practice. Perhaps, the fact that Philadelphia is being defended today by operational missiles in being, by combat ready troops, does not capture the public fancy. But it is just as significant historically as the fantastic new weapons which are still in the experimental stage for future improvement of defense around Philadelphia.

The Army has been conducting communications systems tests and circuit experiments for years in the field of ionospheric and tropospheric scatter techniques.

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BURROUGHS COMPUTATION GUIDES ATLAS INTO O

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by
W. WALTER WATTS, *Brig. Gen., USAR*
Group Executive Vice President
Electronic Components and International Operations
Radio Corporation of America

THE trend toward smallness has been under way in the electronics industry for nearly a decade. With the advent of missiles, satellites and space exploration it has taken on renewed significance—and the micro-module concept is the latest noteworthy advance toward miniaturization.

Military requirements have been responsible for many of our steps forward in technology, and this holds true in the development of micro-modules. The logistic advantage of small size and weight in military electronic devices is obvious. But the micro-module concept offers other equally desirable goals. These include high reliability, durability and performance under extreme conditions, and flexibility in application.

The miniaturizing of electronic devices may be said to have begun with the Bell Telephone Laboratory's invention of the transistor, and with solder-dipped printed wiring. During the same period—around 1950—much important fundamental work, sponsored by the Department of Defense, was being done on components and their automated assembly. There was a progression to subminiature tubes and semiconductors. A maximum density was reached of 50,000 to 60,000 components per cubic foot.

Because of the rapid development of semiconductor devices, the U.S. Army Signal Corps realized that a further significant advance in miniaturization might be possible by a radical new approach. New components, new materials and new techniques were needed. Today, under a Signal Corps contract, RCA and many components manufacturers are carrying out a complete program for the development of micro-modules to meet military specifications. The objectives are ambitious. It is expected that within the next few years micro-modules will make possible a ten-fold —and in some cases a thousand-fold —reduction in the size and weight of electronic field equipment, guidance and control systems and missile components.

Micro elements will be of uniform size and shape for best packaging within the modules. Each component becomes a ceramic wafer about 3/10ths of an inch square and 1/100th of an inch thick, on which conducting and insulating materials are fused. Engineers are talking today of cramming approximately 750,000 components into a single cubic foot.

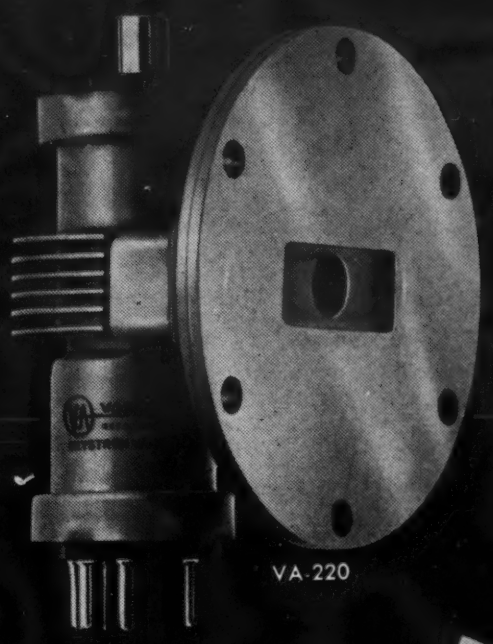
The modules have many additional advantages. They will be versatile and suitable for all low power applications. They will be practical for mass production and automated assembly. An ultimate cost reduction will be effected and maintenance will be simplified. In addition, significant improvements in both performance and reliability will be achieved.

Micro-modules will find early application in five basic types of equipment: portable ground communications, vehicular, guided missile, projectile, and satellite equipment. Inevitably there will be a vast number of electronic manufacturers making micro-modules and components, and unquestionably these devices will eventually find their way into types of military as well as industrial applications.

To see what miniaturization is accomplishing, let us take as an example the new AN/PRC-25 manpack radio

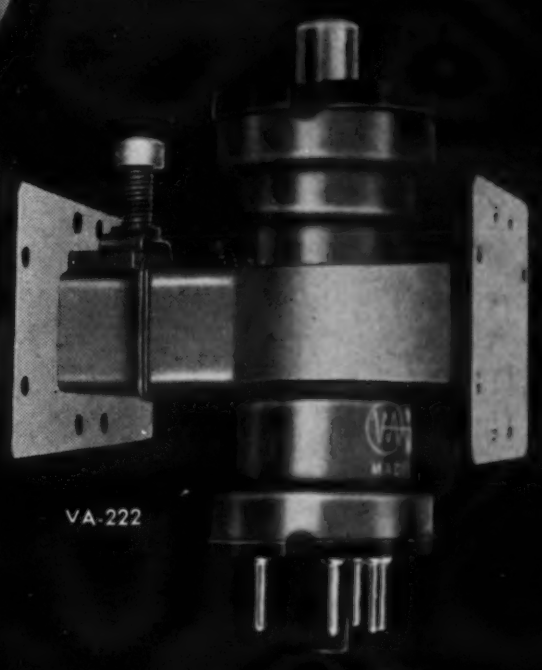
(*Continued on page* 55)

VARIAN PRESENTS



VA-220

VA-225



VA-222

A COMPLETE COMPLEMENT OF 1 WATT RELAY TUBES

...WITH FREQUENCY RANGES COVERING THE COMMON CARRIER, STL, AND GOVERNMENT BANDS

The well known VA-220 Klystron series, long the accepted standard of the relay industry, is now guaranteed for **5000 hours.**

The VA-222 series has all the desirable qualities of the VA-220 series but it is conduction cooled making possible added economies in equipment design...no cooling blower required.

The VA-225A and B are the newest additions to this group of efficient Klystrons. Each provides a 1000 megacycle tuning range within the 7.0 kMc to 8.5 kMc range. The electrical specifications are similar to those of the VA-220.

Write for free comprehensive catalog on Varian Microwave tubes, produced by the world's largest manufacturer of Klystrons.

MECHANICAL TUNING RANGE	
VA-220A and VA-222A	7425-7750 Mc
VA-220B and VA-222B	7125-7425 Mc
VA-220C and VA-222C	6875-7125 Mc
VA-220D and VA-222D	6575-6875 Mc
VA-220E and VA-222E	6125-6425 Mc
VA-220F and VA-222F	5925-6225 Mc
VA-220G and VA-222G	6425-6575 Mc
VA-220Z and VA-222Z	7750-8100 Mc
VA-225A	7500-8500 Mc
VA-225B	7000-8000 Mc

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tools of the SPACE *age*

by
W. WALTER WATTS, ***Brig. Gen., USAR***
Group Executive Vice President
Electronic Components and International Operations
Radio Corporation of America

THE trend toward smallness has been under way in the electronics industry for nearly a decade. With the advent of missiles, satellites and space exploration it has taken on renewed significance—and the micro-module concept is the latest noteworthy advance toward miniaturization.

Military requirements have been responsible for many of our steps forward in technology, and this holds true in the development of micro-modules. The logistic advantage of small size and weight in military electronic devices is obvious. But the micro-module concept offers other equally desirable goals. These include high reliability, durability and performance under extreme conditions, and flexibility in application.

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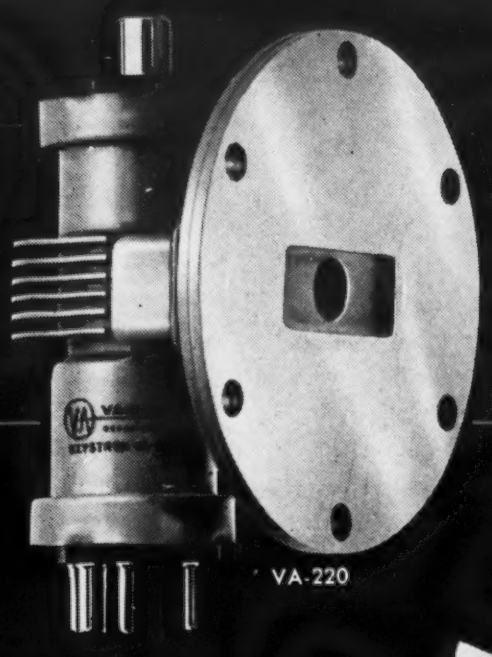
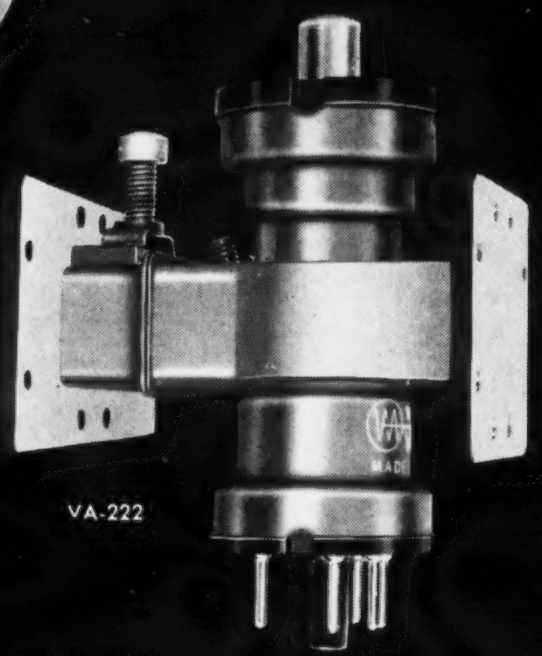


VA-220

VA-225



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DECISION *and* COMMUNICATION

by LT. GEN. JAMES D. O'CONNELL
Chief Signal Officer, USA

OUR national defense needs contributions of systems planners and engineers. Systems concepts and engineering are as vitally important to the Army as they are to American industry. We in the military not only seek to maintain our capacity for combat readiness at all times, but also each year we invest a growing share of our effort in long-range planning and systems concepts.

As an example, the Army Signal Corps has during the past five years reoriented a considerable share of its resources into concept development, systems engineering and operations research. This has been done to counterpoint and to give guidance to our program of scientific research and development.

It is essential to advance systems concepts along with advances in science and technology. This axiom is even more compelling today for we have reached a crossroad in systems and management work. There are a few things which, to my mind, need to be said about this crucial challenge which faces systems engineers and executives.

Important Questions

One big question is: "How can we fit the role of the decision-maker into the new information-handling schemes and their advanced technical means?"

Another one: "How does the dimension of time affect decision-making and dictate the concepts and systems we are going to need?"

Again, "How can we plan for and control the advances of science and technology which are coming along so fast that conditions have been reversed?" At present, invention appears to be the mother of necessity.

To us in the military, these questions seem compelling and it also appears to us that these could very well be important questions facing other government and business organizations.

Consideration of systems as a whole is a matter of special interest to all of us who are professional communicators. One reason is that we communicators invariably find ourselves somehow or other in the middle of all management crises. We are frequently prone to think that the cause of this is our having been left out in the initial phase of policy and operations planning. I have been told by executives that these troubles and difficulties help to develop character. I am sure they also lead to the philosophical outlook which all communicators seem to arrive at in time.

Let me say, before I am misunderstood, that I am not trying to impress you with the importance of communicators. I made this mistake once before and was reminded of the saying by Thoreau. The great naturalist, upon being advised by a friend of the tremendous achievement of linking Maine with Texas by new telegraph lines, thought a moment and asked, "What in heaven's name can the people in Maine have to say to Texans?"

In planning for and developing integrated systems, we surely need to increase the amount of study being given to man himself as a basic course of guidance. We find in man a natural systems model containing unique and well-integrated sensory, information-handling and decision-making mechanisms.

Although a great deal of study is being given to it, it is certainly not fully comprehended and probably never will be duplicated. However, these natural endowments of man have not been able to satisfy his growing needs of association in large political, social and economic organizations.

Quite suddenly, during the last short span of history in the 19th century, we have seen a tremendous revolution in communications technology take place. In less than one man's lifetime, a group of inventor-pioneers worldwide—Morse, Nipkow, Marconi, Baudot, Bell and Zworykin, to name just a few among a very large company—have produced the technical and practical means for today's telegraph, telephone, teletypewriter, radio and television. Truly a staggering increase in mass communication.

Communications Impact on Management

It would appear that this flood of communication capability has both facilitated and frustrated organization cohesion and effective decision-making. I think we are beginning to appreciate that increased volume of communication by itself cannot guarantee *commensurate* or

perhaps even *any* increase in management effectiveness. As we have seen too often, communication can and does overwhelm organizations and executives by a mass—or perhaps we should say a mess—of data, records and reports. I raise the point of this paradox to suggest the need and propose a means whereby communications might be better applied to the attainment of management's objectives.

Must we not recognize the inseparability of the organizational decision-maker with his information-handling system and with its technical communications means? Should we not be studying, developing and administering all three of these as a single entity? And finally, what must we do to start this integration? To us, it does not appear to be started. I am sure it will not be popular with the decision-maker and perhaps the executive to suggest that his previous inviolate character and function be critically examined along with his systems experts and his communicators.

But perhaps I should at this point take off my communicator hat and become a manager and executive, which I am also, and volunteer to be a guinea pig for this kind of evaluation as a manager. I think that decision-makers and executives will accept this kind of treatment whenever we communicators are able to convince them that it will improve the system's effectiveness.

How then can we ever expect to do the whole system's job by scientifically studying and developing the information system and its communication-electronic means without doing the same for the essential functions of the decision-maker himself?

Operations research has already demonstrated its potential for this purpose but still appears to be a youthful character back in the wings who is not fully recognized and seldom gets a speaking part.

The Importance of Time

Consider now the subject of *time*. In science, we have learned to measure time in microseconds and require Maser atomic clocks to obtain the necessary accuracy. But it sometimes appears that in management, time is as variable as the weather, sometimes marching, racing or standing still.

I realize that management is now beginning to consider time as fundamental as cost considerations in program scheduling and control mechanisms. The question we ask is: "How can modern communications be more effectively utilized to save time, to reduce lead time?"

And how much recognition are we giving to the fact that the well-publicized technological race between business enterprises—and unfortunately also between nations—is actually a lead time race? The assurance of success in this race over a long pull goes obviously to that organization or nation that most effectively compresses the time cycle from conception to practical realization.

So much for the vital importance of time. Now, what can be done to help systems concepts to close the existing gap behind scientific advances? Perhaps I am overly sensitive on this subject, but the impact of communications and electronics on management control and systems design has been most dramatic. It has made a big impact on our military thinking. Electronic data processing is a good example to illustrate the modern dilemma wherein science and technology are presenting new capabilities faster than men and management can assimilate them.

Communications Means Command Control

The Army is facing the same problems in basic concept and system design that confront other large organizations, both in government and in business.

The modern Army commander, for example, directs a combat force whose effectiveness is determined by three basic factors—firepower, mobility and command control. For firepower, he has a variety of weapons ranging from rifles to atomic missiles. His mobility is attained in a variety of air, ground and water vehicles. Command control represents the Army equivalent of the management information system and associated technical means. It is this element, command control, that invariably poses the most difficult systems problems in keeping pace with increased firepower and mobility.

At the present time, there are United States Army elements, advisory groups or troop units assisting and supporting 73 different nations. To make vital information instantly available for decisions at widely-scattered military headquarters and at the seat of National Government, the Army operates a world-wide communication system.

This system of major world-wide radio and wire circuits is employed to keep command communication intact to U. S. Army headquarters and elements dispersed throughout the world. The system also serves the Joint Chiefs of Staff, unified commands, the Department of State and Navy and Air Force elements, as they require its use. I should say that in turn the Army receives communication services from the State Department, Air Force and Navy systems. We are completely free in passing traffic over each other's systems and have common supports.

The Army global communications system is not simply a well-engineered fixed communications system with modern equipment operated out of major headquarters. More fundamentally, it consists of capable and responsive combat communications, trained and ready for emergencies, carrying out their task and mission to keep command control intact.

As an example, let me take you back to June 25, 1950. The place—Seoul, Korea. Time—2:00 p.m. A phone rings at the American base in Seoul. Someone says, "The Republic of Korea is being invaded by an army of North Korean Communists who are marching on Seoul." The American Ambassador in Seoul asks the small Signal Corps detachment to get him through to General MacArthur in Tokyo. They do so.

Later, at 9:00 a.m. on June 27th, Tokyo gets an urgent radioteletype message that reads: "Evacuating Seoul. Embassy radio station and telephone exchange being destroyed. This is our last message." Tokyo replies, "We will stand by for you on manual." Then silence. Command control is no longer intact. Both intelligence and command are disrupted.

Three hours and 26 minutes later, Tokyo receives a message from Suwan Air Strip, 25 miles south of Seoul. Two mobile manual radio stations had been pressed into service, and command control is again established.

The Army system is being adapted continually to handle new communication or data transmission requirements such as electronic data processing. Already, through this adaptation, personnel assignment centers overseas have been deactivated, saving somewhere in the neighborhood of $8,000,000 per year, and individual personnel assignments are now being made to the unit overseas prior to departure from the United States.

Increasingly, overseas requirements are being handled from the United States on the same basis, resulting in lower stockage levels in overseas depots and faster service to the customer. The end is not yet in sight by any means.

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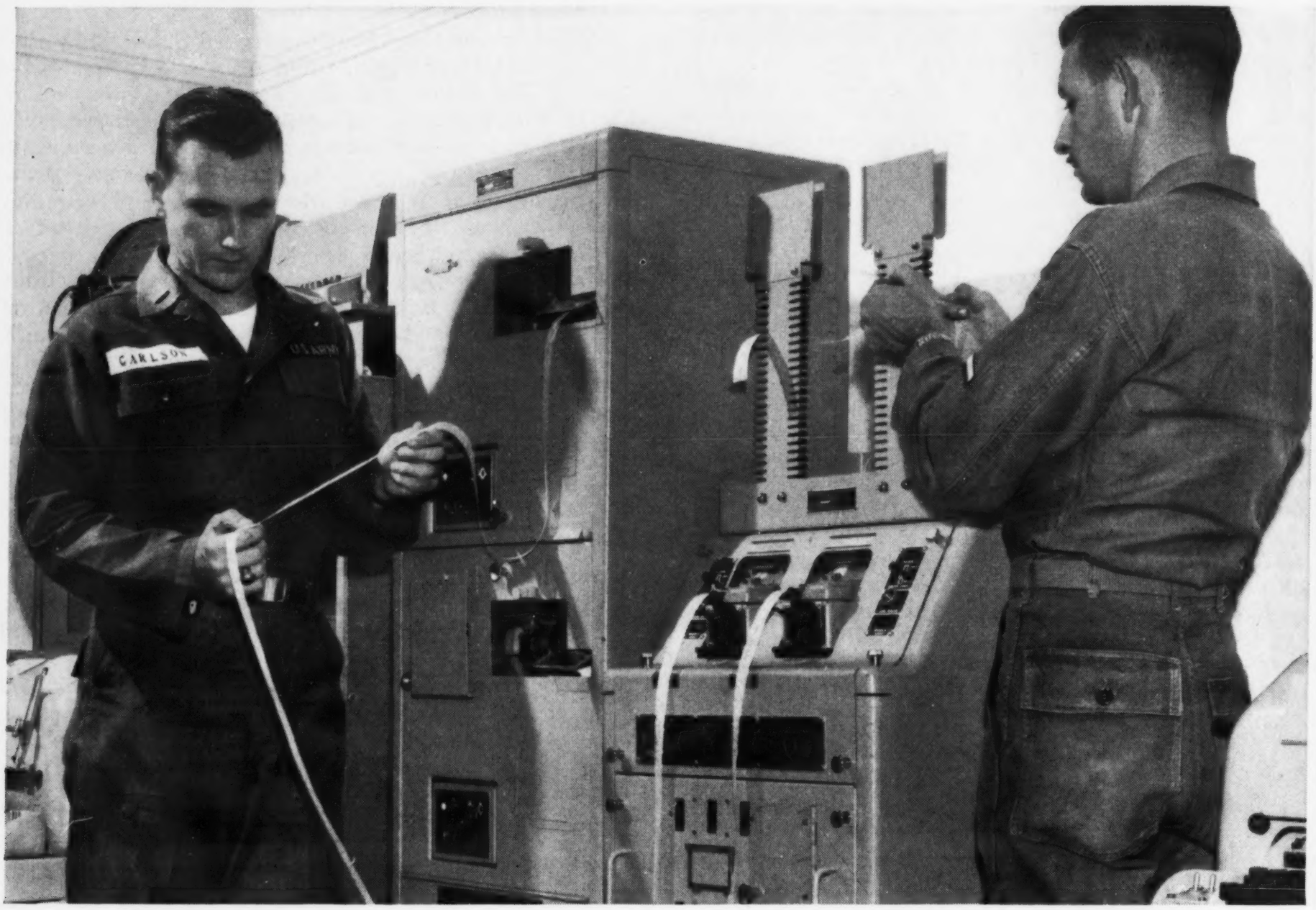
TOP LEVEL TALK

relayed on teleprinted tape



At U.S. Army field communications centers, Kleinschmidt torn tape relay units send, receive, retransmit messages to widely-dispersed commands

"Getting the word" from top command to outlying units in the field can create a communications traffic jam. This compact relay unit solves the problem. It quickly, accurately, automatically numbers and *prints* each message as it simultaneously *relays* another message to one or 100 receivers in the communications network! Developed in cooperation with the U. S. Army Signal Corps, the unit's applications include telemetering, integrated data processing, torn tape communication. In recognition of Kleinschmidt's high standards of performance, equipment produced for the U. S. Army is manufactured under the Reduced Inspection Quality Assurance Plan.

KLEINSCHMIDT

DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILLINOIS

Pioneer in teleprinted communications systems and equipment since 1911

We are convinced that we have not really begun to exploit adequately an integrated communication and electronic data processing system to obtain new dimensions in control.

Let me make clear that we are not satisfied with the design of our present global communications system. There is a major systems engineering job in prospect to meet many new requirements. Figure 1 gives an indication of one of these new requirements. It shows the multiple steps we are now going through to process a secure message from the originator to the addressee.

This system comprises too many steps, too much time and too many people, and we propose to replace it with a more efficient system which is shown schematically in Figure 2. It is called UNACOM.

Users are connected to local automatic circuit exchanges incorporating electronic computer techniques. Through these techniques, the originator can be switched automatically through regional and other local exchanges to the addressee. Systems users are provided with telephone-like instruments which are equipped with signalling keys by which they can transmit coded instructions to the circuit exchange. The price for this advance must be paid in terms of new equipment, but the time factor in message

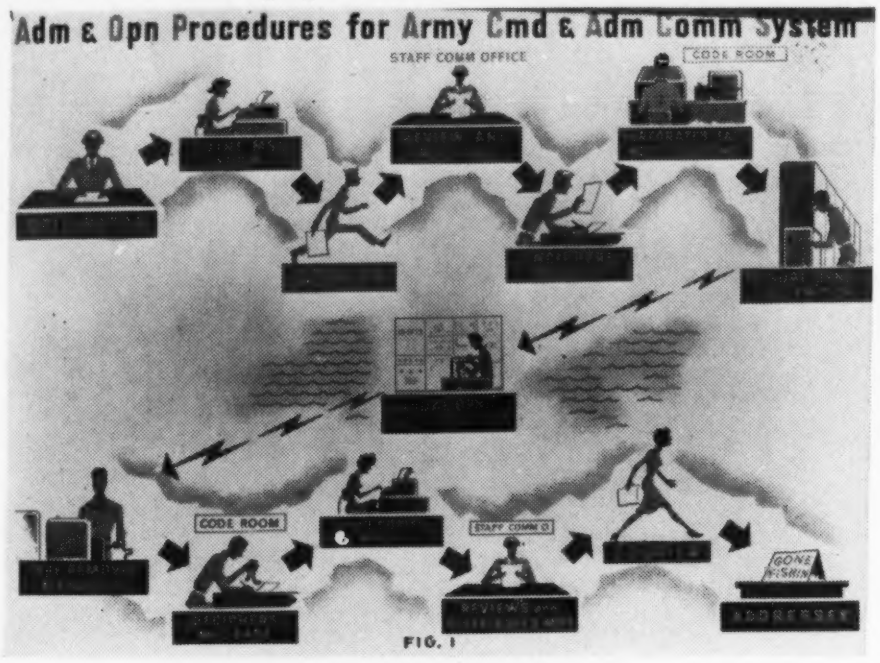


Figure 1

handling will be drastically reduced and the savings in personnel will be very substantial.

Tactical Communications

I would like to turn to the tactical communication picture. The requirements for quick response and drastic time reductions at the global level are even more vital within the Army combat forces. While shorter distances are involved than in global systems, the amount of detailed information necessary for combat is growing. There exists a real problem for the much more rapid collection, reduction, evaluation and display of information related to combat decision-making. For example, employment of an atomic missile by a field army commander poses such critical problems as describing and locating targets, determining weather conditions affecting radiological fallout, and having accurate and reliable information on the location of friendly forces—only a very few of many considerations which he finds necessary. Reliability is a basic characteristic in the recently organized Pentomic Army system of communications.

Atomic weapons and the reorganization of the combat Army have forced this issue. Complete systems concept redesign has been accomplished on a crash basis to retain command control under new survival requirements. Considering the problem with which we were faced, we planned a systems design with more dispersion, more rug-

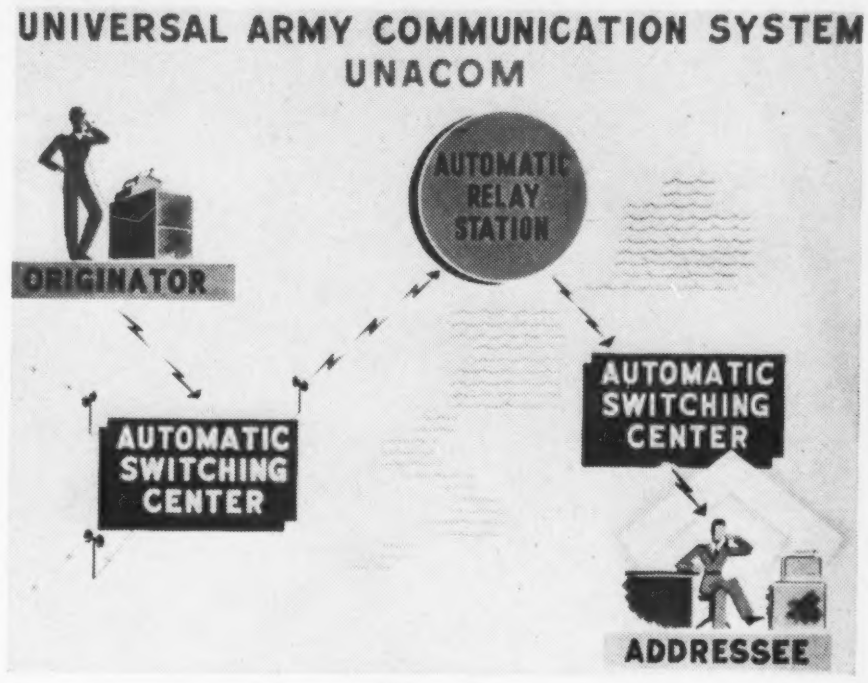


Figure 2

gedness, and more redundancy. This concept enables it to resist complete destruction and loss of command control, even in the face of an atomic attack.

The analogy of the ruggedness of a spider web can be seen from the design of a tactical area communications system in Figure 3. Here you see many dispersed communications centers, which are denoted by the small dark circles. These are interconnected by multiple axes of communication and form roughly a grid pattern which is highly flexible. The multiple communications center and the numerous circuits available provide alternate routing so that the destruction of parts of the system will not render it inoperable. This particular figure shows the division system; the system for the field army is of course more extensive and has a larger grid pattern. The communications centers are themselves mobile so that the entire system can displace in any or in all directions.

One of our urgent requirements is to incorporate electronic computers into the area communications system to provide integrated data processing service for the combat field army. The Army research and development program for militarized data processing is already well-advanced. Military decision-makers, of course, face somewhat similar problems as business executives, that of correlating and reducing data and analyzing the many variables in an operating situation.

The largest model of the family of data processors to be used by the Army's combat forces is a high-capacity machine designed to satisfy performance requirements

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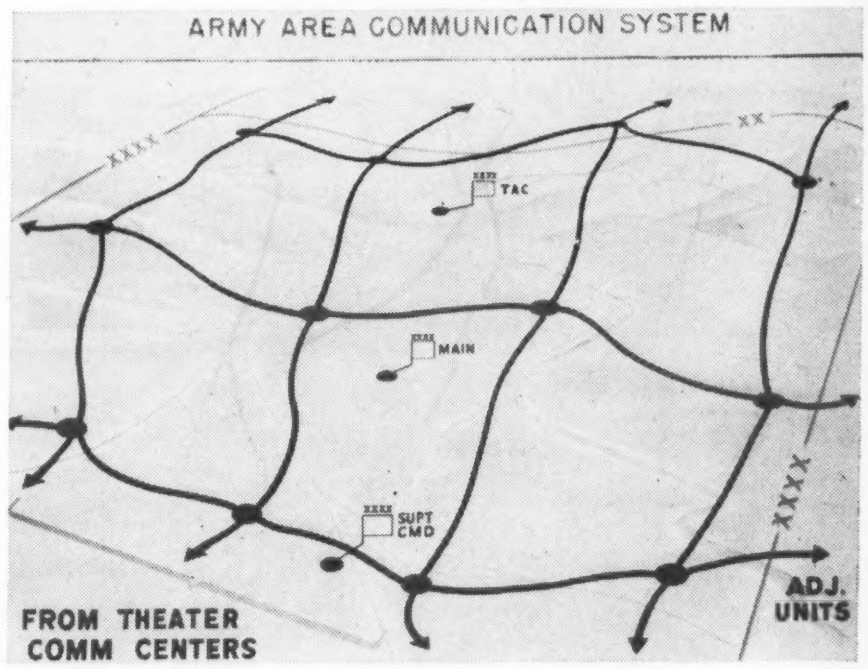
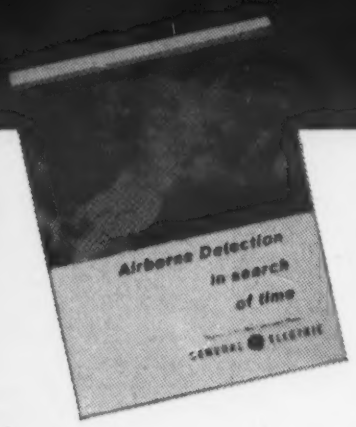


Figure 3

DETECTION

LMED'S airborne **GENDARME*** will illuminate the unknown



One or many, in clouds or clutter . . . nothing will elude GENDARME, LMED'S new *Airborne Early Warning and Control radar. New AMTI (Airborne Moving Target Indication) and Pulse Compression techniques sharply curtail sea clutter, improve target detection. New "built-in" height finding provides a truly 3-D search system. New data processing methods insure completely automatic operation. For further news on LMED's detection developments write for brochure: "Airborne Detection . . . in Search of Time," **Dept. 7S.**

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LIGHT MILITARY ELECTRONICS DEPARTMENT
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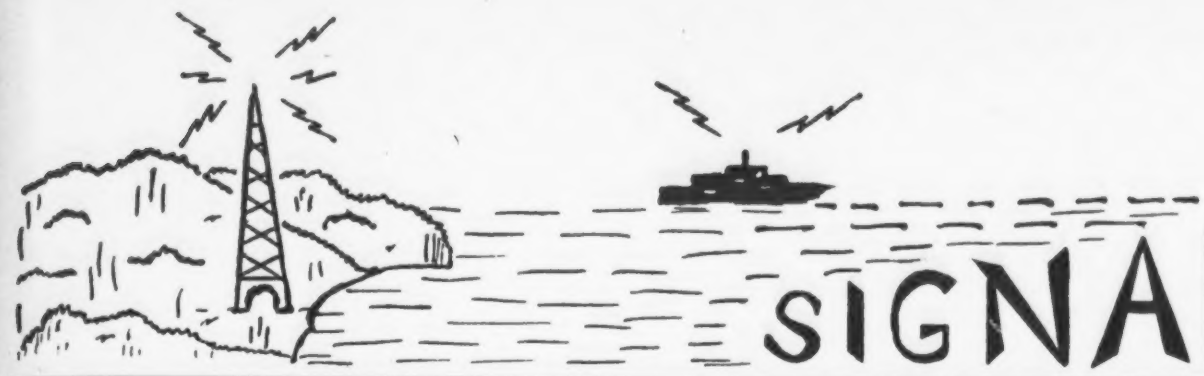
A DEPARTMENT IN THE DEFENSE ELECTRONICS DIVISION



SIGNAL·GRAM

— GOVERNMENT —

THE NASA has chosen McDonnell Aircraft Corp., St. Louis, Mo., as the source for the design, development and construction of a space capsule capable of carrying a man into orbital flight around the earth. Twelve companies submitted proposals in the NASA competition for the satellite capsule and its subsystems which probably will exceed $15 million total cost. The satellite, planned for launching in about two years, is part of the joint civilian-military PROJECT MERCURY to put man in space. The complete electronic instrumentation for the satellite will be provided by the Collins Radio Co., Cedar Rapids, Iowa. PROJECT SATURN is the name designated for ARPA's 1,500,000-pound thrust super booster for heavy space payloads under development at Huntsville, Ala. The booster is expected to be test flown in 1960.

A FIVE-POUND ATOMIC DEVICE for production of electricity has been developed for the Atomic Energy Commission by The Martin Co., and Minnesota Mining & Manufacturing Co. The highly efficient atomic unit,uses polonium, a radio isotope, and has no moving parts. It is said to be capable of generating dependable electric current for a year or more. Scientists reported the new device is particularly suited for satellites or other uses demanding lightweight power sources which can run for months without recharging or refueling.

ACTIVITIES AT STRATEGIC AIR COMMAND HEADQUARTERS in Omaha, Nebraska, may soon be seen by Defense Department officials in the Pentagon in Washington, over special television equipment utilizing ordinary telephone lines. Before entering the telephone lines the electronic picture impulses are coded much like teletype messages. The codes may be changed daily or more frequently, if necessary. The system, being constructed by ITT, would transmit such information as briefing boards, aircraft position, printed material and other secret SAC data. Audio lines will permit officials to view and discuss the events at SAC as they occur.

TOTAL NET VALUE OF MILITARY PRIME CONTRACTS during the past fiscal year totaled $21,794,000,000, of which 74.2% went to the top 100 prime contractors. The top ten major defense prime contractors were: Boeing Airplane Co., $2,131,000,000; General Dynamics Corp., $1,382,000,000; General Electric Co., $783,000,000; Lockheed Aircraft Co., $659,000,000; North American Aviation, Inc., $647,000,000; Douglas Aircraft Co., $755,000,000; United Aircraft Corp., $661,000,000; American Telephone & Telegraph $513,000,000; Hughes Aircraft Co., $472,000,000; The Martin Co., $400,000,000.

CONTRACTS: ARMY: Kleinschmidt Div. of Smith-Corona Marchant, 5 contracts for tactical sending and receiving units, standard page printers, receiving reperforators, tape transmitter distributors, and tape perforators, totalling $2,087,437; Precision Instrument Co., instruments, $910,000; Sperry Rand Corp., classified work on SERGEANT missile and its ground handling equipment, $22,000,000. NAVY: Hoffman Labs. Div., Hoffman Electronics Corp., manufacture of "Sonobuoy" anti-submarine devices, $1,500,000; Packard-Bell Electronics Corp., production of advanced electronics equipment, $5,000,000; Electric Boat Div. of General Dynamics Corp., to build the first of a heavier and improved type missile-carrying POLARIS submarine, approximately $105,000,000. AIR FORCE: Bendix Aviation Corp., Radio Div., long-range search radar, $1,372,973; Telecomputing Corp., data processing services at Vandenberg AFB, Calif., over $400,000; Lockheed Missile Systems Div., continued testing of research vehicles in support of BOMARC program, over $8,000,000; Western Union Telegraph Co., installation of new, automatic high-speed communication centers, and related personnel training at five overseas Air Force bases, over $4,000,000.

— INDUSTRY —

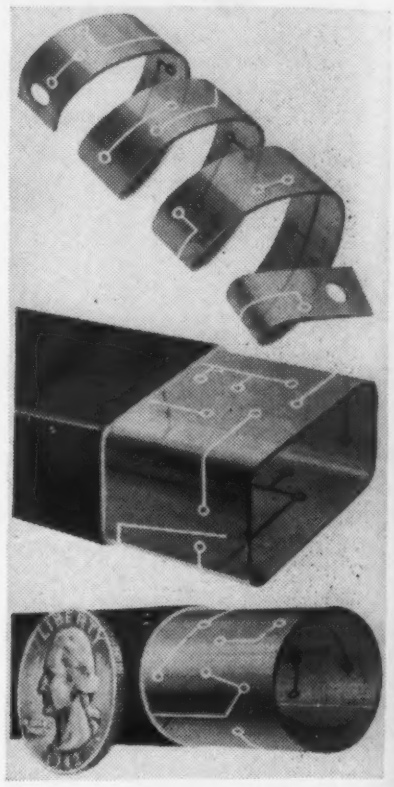
THE SPRAGUE ELECTRIC COMPANY, North Adams,Mass., has purchased the magnetic component and filter product lines of the Hycor Division of the International Resistance Company of Philadelphia, Pa. Sprague will take over the manufacture of the various Hycor products lines, except the manufacturing operations on precision resistors which are not involved in the sale. The new products will be sold by Sprague under its own trademark.

(*Continued on page 59*)

the age of

PRINTED CIRCUITRY

by
JOHN D. COCHRANE
Technical Director
Formica Corporation



Today, copper-clad laminated plastics for printed circuitry are available for many different requirements. Some, such as the Formica laminate shown above, are flexible for use in confined areas where flat boards or curved ones would be too bulky.

The age of printed circuitry is with us.

The days of multi-colored, complicated electrical and electronic wiring are past. Today's printed circuits are standard in computers, television sets —even washing machines—because they are less expensive to manufacture and more efficient than the "spaghetti" of years gone by.

Printed circuitry is in such wide use that it is difficult to realize that the future of printed circuitry is as bright as its brief, but brilliant past.

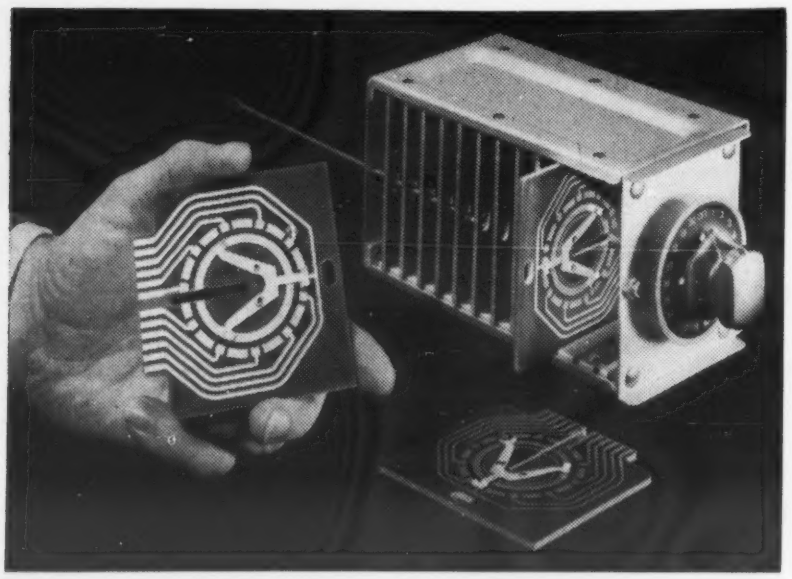
Some time ago, the Marketing Research Department at Formica Corp., undertook a survey of printed circuitry and an analysis of its future. Since the survey was conducted in mid-1958, it used 1957 as the calendar year to be analyzed. After talking to manufacturers of almost everything —from automobiles to electronic testing equipment—researchers came up with some startling facts.

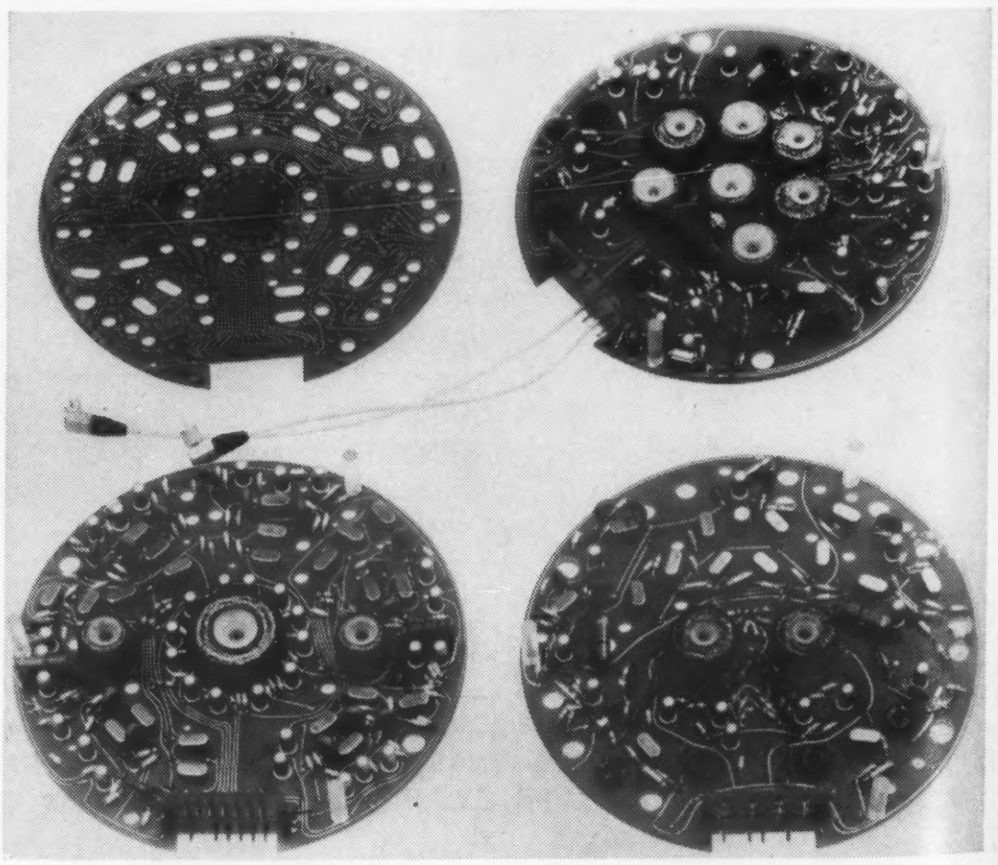
Their conclusion: There might well be as much as a 500 percent increase in the use of printed circuits by 1961.

Here's the typical way printed circuit consumption between 1957 and 1961 compares, according to the recent prognostication of Formica Corporation's marketing research department:

INDUSTRY	*1957*	*1961*
Automobile	.8%	6.0%
Communication Equipment	.3%	8.2%
Computers	.7%	7.5%
Military Electronics	4.4%	28.2%

(*Continued on page* 47)



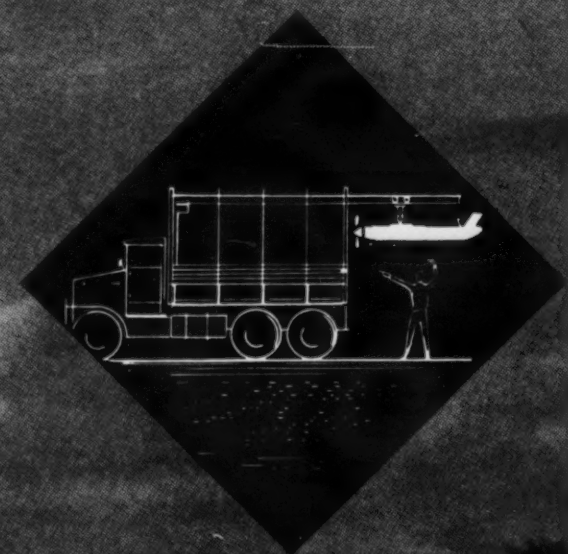


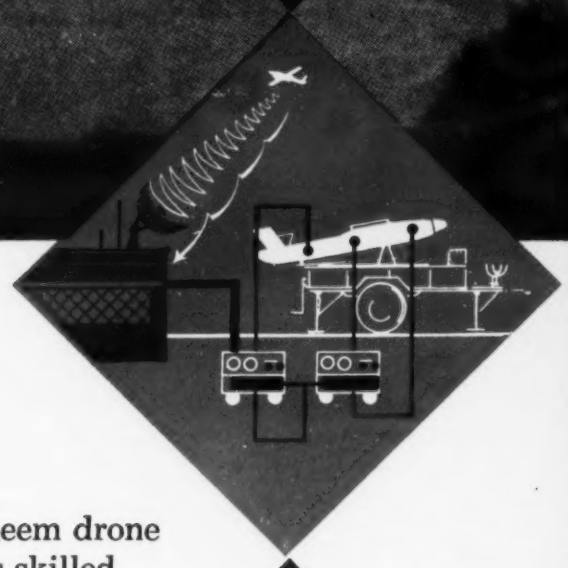
Above: Instant servicing of shipboard radio is achieved in this control unit for the U. S. Navy. Each of the Formica printed circuits plugs into its own individual socket. Right: Printed circuit of Formica copper-clad laminated plastic boards form the basis for several of the modules included in the Vanguard satellite. One module contains the basic telemetry encoder; one carries the Lyman-alpha peak memory unit and orbital switch; the third carries the meteoric-collision experiment amplifier and counter.

Photo of an official flight test of AN/USD-2 drone, U. S. Army Test Station, Yuma, Arizona

MISSION ENSURED

with a reliable RHEEM drone system





From launch to touch down, a Rheem drone can be counted on. Behind every Rheem drone system is the rich accumulated experience of hundreds of engineers and technicians skilled in aeronautics, electronics, and ordnance. Backing up this talent are thousands of the nation's best production workers.

Typical of Rheem capability in the design and production of complete drone systems is the U. S. Army Signal Corps Project, the AN/USD-2. From initiation to successful flight test, this surveillance drone project was accomplished in just twelve months at the Downey, California, plant of the Rheem Defense and Technical Products Division. Rheem ingenuity and know-how provided not only the drone airframe but also important components of the telemetering and ground support systems.

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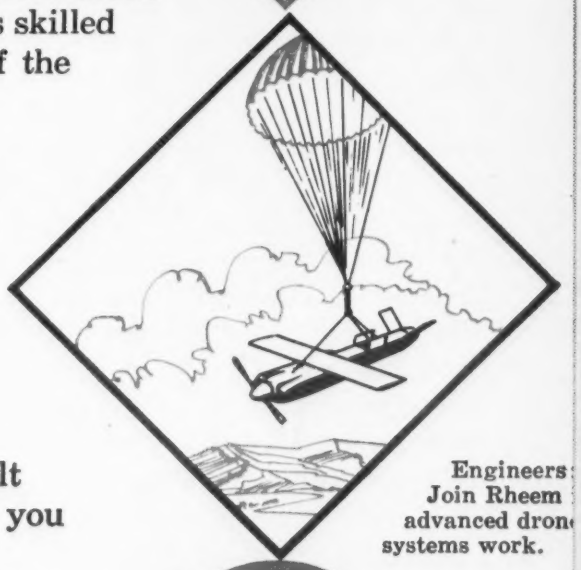

Engineers: Join Rheem advanced drone systems work.

For more information on Rheem drone systems, write for Data File S-704-1

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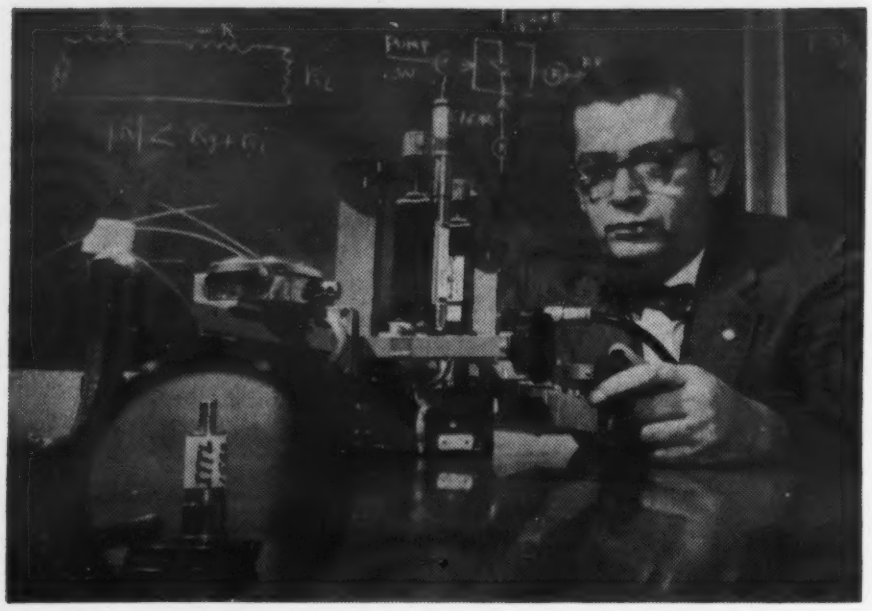
Rheem

by Maj. Orvil S. Ostberg, SigC, USAR,
Administrator, Research & Development
International Telephone & Telegraph Corp.



COMPONENTS

the parts of the picture

Parametric amplifier. Heart of the device (magnified, foreground) is a new special small silicon diode.

IF A SINGLE SENTENCE COULD be said to describe the United States Army Signal Corps, that sentence would read, "Communications is our business." The same phrase may well be applied to the world-wide operation of International Telephone and Telegraph Corporation.

Because of this unity of interest and because many of ITT's research, manufacturing and operational activities tie in directly with the military, the problems faced by both organizations are markedly similar in some respects.

One of the most important of these problems is the improvement of electronic components. Accordingly, both organizations support extensive programs devoted to components improvement.

Some of the reasons underlying the need for more reliable components, especially military components, are obvious. Others, equally important, are not equally apparent.

It is obvious, for example, that no military commander can control his forces and deploy them effectively in battle unless he can transmit orders quickly and reliably while simultaneously receiving intelligence concerning enemy forces and their actions. Because modern military tactics envisage supersonic attacks on targets thousands of miles away, dependable, instantaneous electronic communications controlling these attacks, or the defenses against them, are a must. Obviously the components in such operations must be reliable.

Similarly, a modern military communication unit usually forms one part of a chain, such as the ITT-operated Dew Line, the vast radar warning system north of the Arctic Circle that guards the North American continent against attack across polar regions.

The Dew Line is connected, by means of an extensive communication system, to a command center in the United States. Here, radar data, relayed from the Line, may be received and appropriate action taken.

Obviously, any such interrelated system is only as good as the units which comprise it and these, in turn, can be used effectively only if the components of each unit operate reliably. Electronic chains of command cannot afford weak links.

Importance of Speed

An equally important, but less readily apparent, reason why components must be reliable is speed itself—the speed at which modern communication and weapon systems operate. For example:

One hundred years ago a military officer scribbling a battle order would not have been inconvenienced seriously if the point of his pencil broke and had to be resharpened. In such an instance a delay of a few seconds probably was not important. Today, a broken electronic component, causing a few seconds delay in the transmission of a signal to a supersonic atomic missile, could be disastrous.

Recently, J. Lewis Powell, of the Office of the Assistant Secretary of Defense for Supply and Logistics, pointed out that our first military plane in 1910 had a guaranteed speed of 42 miles per hour. By 1945, Powell noted, the speed of the aircraft had increased to 470 miles per hour. Ten years later that speed had catapulted to 1,500 miles per hour. Today, Powell reminds us, we calmly accept speeds of satellites and moon probes of 18,000 to 25,000 mph.

For thousands of years, man's speed was limited by what Powell terms the "oat barrier"—the speed of a horse on which a man was mounted. Less than 150 years ago steam power broke this barrier. Now, the speed curve, which was level for thousands of years, has gone almost vertical, Powell observes.

Relatively speaking, the "down time" of military signal equipment is increasing. Better components furnish one answer to this problem.

Another component problem—the addition of reliability percentages—is inherent in the demand for electronic equipment that will perform a larger number of more diverse tasks. Such equipment, despite circuit simplification efforts, means increased use of components and increased reliability problems.

If a single component has a rated reliability of 99%, theoretically it can be expected to fail once in every 100 times it is used. Addition of a second 99% reliable component to that circuit will not result in a total reliability of 99%. Instead, the theoretical reliability will fall to 99% of 99% or 98.01%.

The formula for this is:

$P_t = P_1 \times P_2 \times P_3 \times \ldots P_n$

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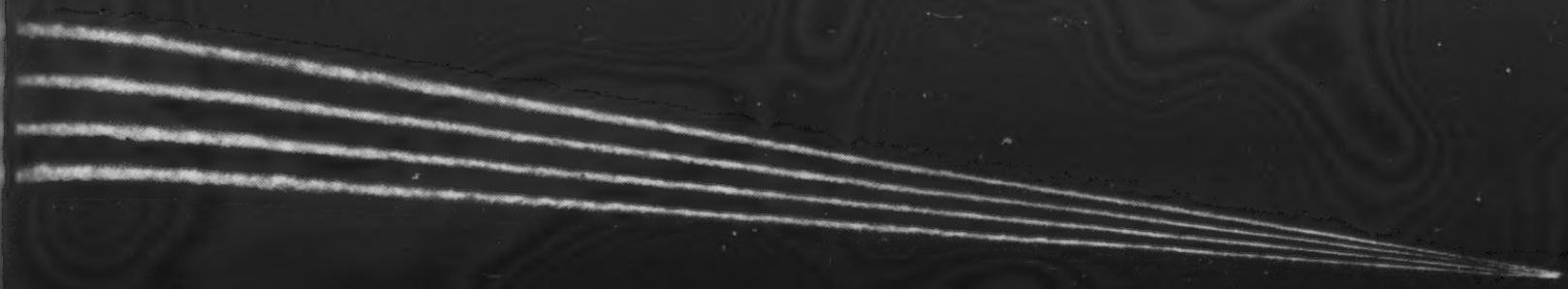

TEAM POWER

New weapon in the Air Force arsenal

The mightiest of air powers, the United States Air Force, has added a new kind of weapon to its arsenal—*teamwork* of private industry.

Defense of the free world requires unprecedented scientific achievements—new weapons systems so advanced they demand the specialized capabilities of many organizations.

The Air Force was first to utilize the great creative power available in the *combined* abilities of private industry—the TEAM concept. This Air Force partnership with industry has resulted in today's highly successful *Project Level Systems Management.*

Recently the specialized talents of eight organizations were joined together by Hoffman Laboratories Division as systems manager in developing a complex electronic reconnaissance system for the Air Force. The success of this program is proving the value of combining the talents of several companies to meet the requirements of today's complex weapons systems.

This kind of teamwork transforms healthy competition into powerful cooperation . . . providing better answers faster and at less cost to the nation in terms of time, money, and manpower.

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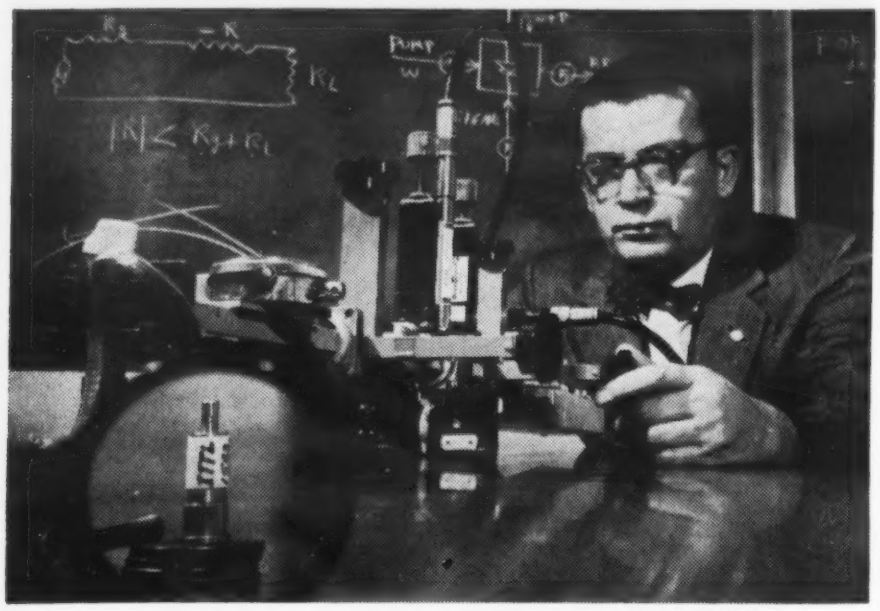

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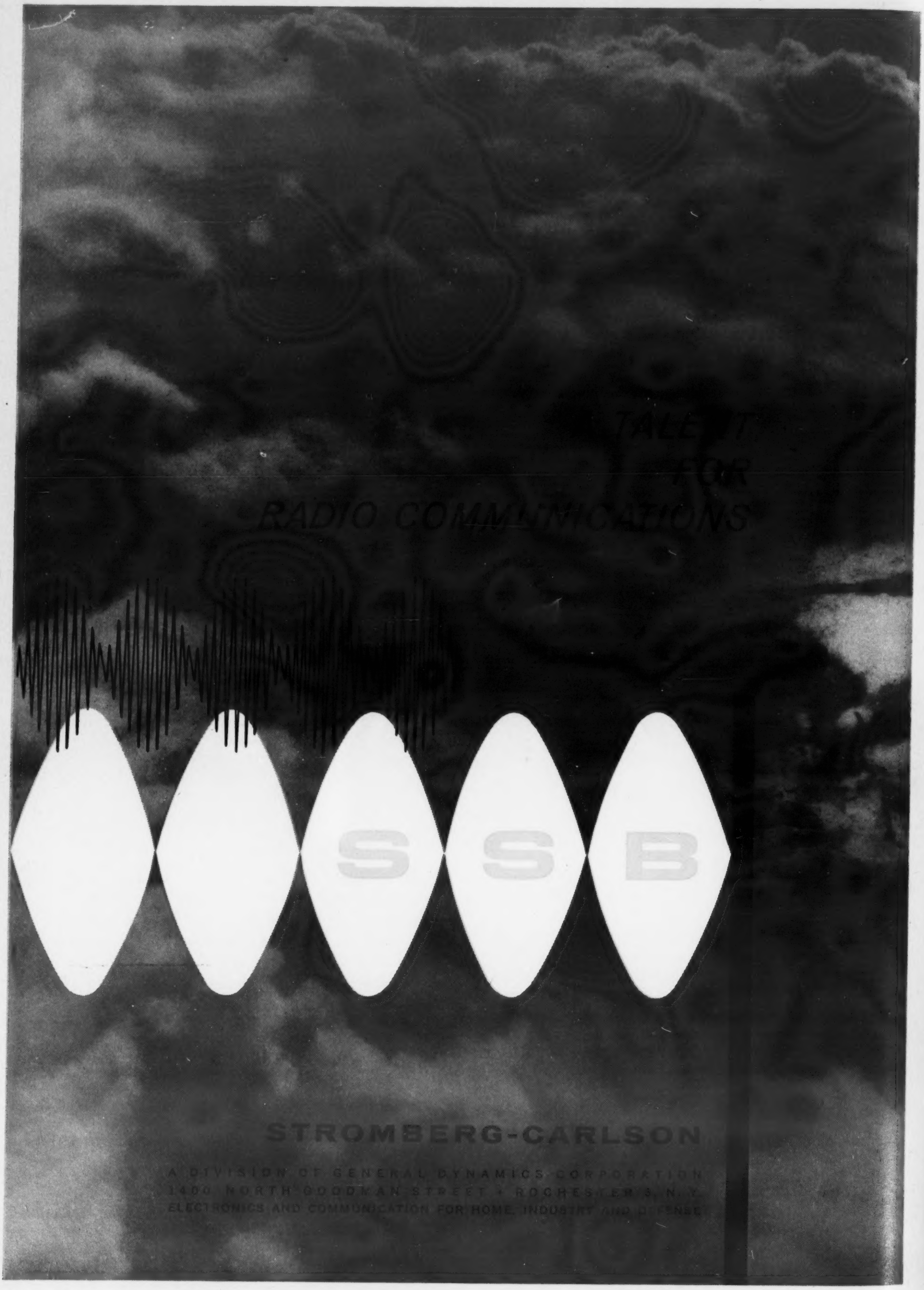
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Provides 28,000 stabilized channels from 2 to 30 megacycles, with a transmitted peak envelope power output of 100 watts.

Receive input power: 50 watts. Average transmit input power for voice: 150 watts.

Available soon.

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Components: The Parts of the Picture

(*Continued from page* 42)

equipment, the theoretical chance of that equipment working at any given try would be only about 36.5%.

Actually, military components demand a much higher degree of reliability in the order of 99.98% and upwards. But to achieve this is in itself a problem.

By considering some of the components of a Nike system—approximately 1,500,000 parts (not all electronic) including 12,000 resistors, 5,000 capacitors, 460 relays, 1,250 coils, 217,000 feet of conductor wire, 2,000 feet of coaxial cable, an idea of the magnitude of the reliability problem may be gained. And the Nike is a fairly simple missile.

It was pointed out recently by the Aircraft Industries Association publication, *Planes,* that the electronic system of a typical missile has approximately 37,000 items. Each must function properly if the missile's flight is to be a success. If each item is so reliable that it will fail only once in 100,000 times, the theoretical chances are that one missile firing in three will be a failure.

The reliability problem is considerable even in much simpler equipment. The curve showing the probability of failure, as a function of the number of vacuum tubes in equipment carried on a 10-hour flight, is startling. Airborne equipment with 150 vacuum tubes has an almost fifty-fifty theoretical chance of failing in 10 hours. For airborne equipment with 500 vacuum tubes the theoretical chance of failure within ten hours is roughly 88%.

Need for continuing accuracy of components within tight tolerances complicates the problem. As an illustration, consider the operation of an oscillator circuit which may have to be accurate to within .0001%, or one part in one million. A variation of 1% in one of the components may easily throw the oscillator's frequency outside the desired limit. Such a component cannot be said to have failed in the sense that it no longer operates. But the end result may be the same as a failure and points up the need for reliability in accuracy.

Additionally, component specifications constantly call for greater ability to withstand adverse environmental conditions. Components must be ruggedized, miniaturized and made more heat and cold resistant.

Equipment Designers

Have equipment designers reached the point of diminishing returns in their increasing demands upon component manufacturers? The answer is, "probably not." However, it might be timely to re-examine the "key component" concept whereby equipment designers design systems based on technological breakthroughs in the component field.

For example, an "atomic clock" incorporating certain new principles has been developed at ITT Laboratories, Nutley, N. J., for use as a highly stable frequency source required in self-contained airborne navigational systems.

The accuracy of this device can be illustrated by imagining two cars making a trip from New York City to San Francisco with their speeds regulated by two "clocks." Variation between the two cars, as regulated by the clocks, would be so slight that one car would cross the finish line first by a distance approximately that of the thickness of the chromium plate on the front bumper.

What application does the accuracy of this "clock" have in the communications business? Frankly, no one fully knows although the future seems to hold many possibilities in exploiting this device. However, the example shows the new horizons that can be opened by a reversal of present practices whereby equipment designers impose specifications upon designers of components.

Parametric amplifiers have been developed which provide marked improvement in the reception of microwaves. When applied to microwave links, for instance, they enable such over-the-horizon (O/H) radio links to be extended 100 miles over present 250-mile limits. Alternatively, such devices permit transmitted power of the links to be cut by as much as 90% while providing the same service as previously. The development of a new component, a special small diode, makes possible this great improvement in system performance.

The advantages of the parametric amplifiers include another factor, cost. Operation at reduced power means operation at reduced cost with less expensive equipment—not to be overlooked. (See photo page 42.)

Although it is impractical to put a dollar value on any specific communication facility in terms of national security, such costs must be considered in terms of the over-all national investment in military communication equipment.

According to a recent special inventory report released by the House Government Operations Committee, the communications equipment owned

NEW All-American!

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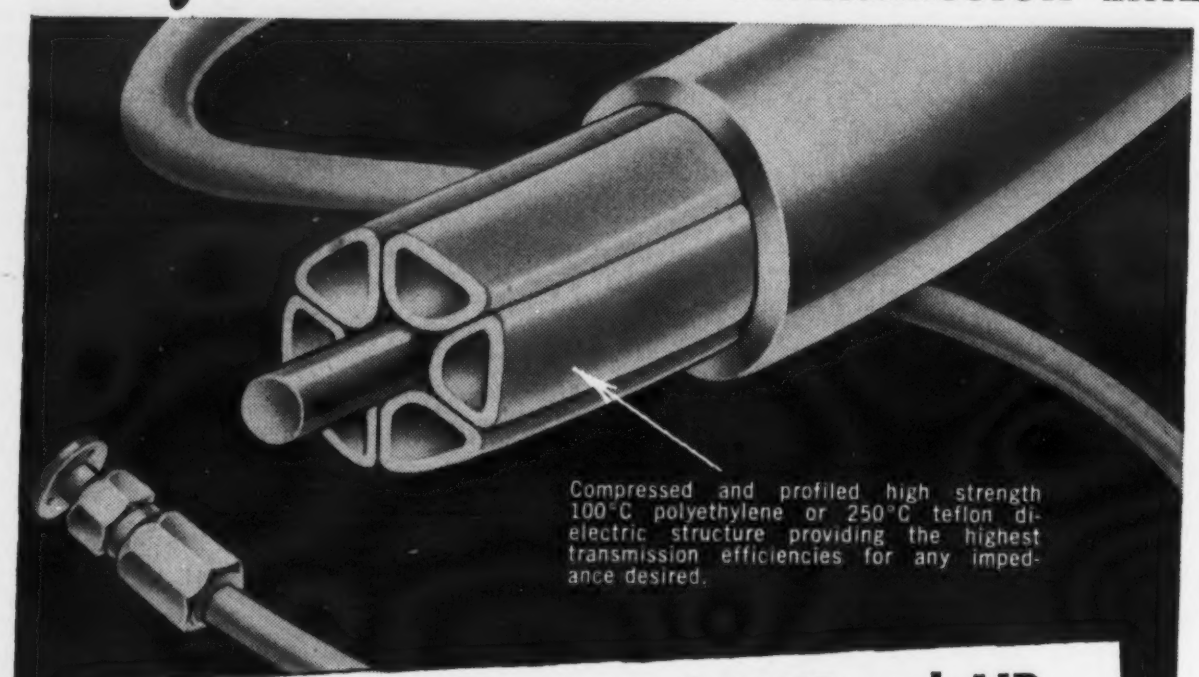
Compressed and profiled high strength 100°C polyethylene or 250°C teflon dielectric structure providing the highest transmission efficiencies for any impedance desired.

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Spir-O-line®—Prodelin's latest contribution to air-dielectric transmission—combines the low loss of air dielectric with the high power of solid dielectric lines by using dielectric tubes compressed and profiled into a symmetrical supporting structure. *Spir-O-line* is available in continuous lengths up to 1000' with reliably low VSWR and 50, 70, 75 ohm, and other impedances; the 50 ohm line usable up to these cut-off frequencies: 3/8" - 15.0 Kmc; 1/2" - 10.0 Kmc; 7/8" - 5.0 Kmc; 1 5/8" - 2.8 Kmc; 3 1/8" - 1.5 Kmc. The normally non-corroding aluminum-alloy outer conductor is available with a non-contaminating polyethylene jacket for caustic environments.

FEATURES

- No special techniques or tools required to make up cable-connector assembly
- No metallic welds or dielectric splices are used regardless of cable length
- Continuous high-conductivity aluminum sheath assures maximum pressure tightness and weather protection
- Uniform straight lay tubular support throughout keeps inner conductor smoothly centered on bends
- Pressure-tight and high tensile cable-connector assembly can be made with only hand-tightening
- Dielectric structure makes continuous and intimate line contact with both conductors without spiraling — yielding best broadband performance, highest power handling capacity, lowest attenuations, and VSWR smoothness
- Both cable and connector available for −90°C to +250°C operation
- Terminates in standard EIA (RETMA) dimensions

PLUS

Spir-O-lok Connector

Amazing Prodelin development! Adequately pressure-tight for lab use when hand-tightened . . . ready for field service when wrench-tightened. Specifically designed for use with soft aluminum tubing to provide highest tensile strengths without tube distortion. No special techniques, bulky fixtures, or non-standard tools required. *May be used again and again without redressing tubing or replacing connector parts!* Saves time and money! RETMA dimensioned.

Specify Spir-O-line HI-TEMP with Teflon for 250°C operation

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Reconsider your cable requirements now and ask how Spir-O-line can provide new life with added economies in your service! WRITE FOR TECHNICAL BULLETIN TODAY

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by the Army, Air Force, Navy and Marine Corps, as of June 30, 1958, was valued at $2,557,411,000.

Considering the accelerated rate of obsolescence of this equipment, compared to commercial equipment, as well as the maintenance costs, there is a staggering annual expenditure on components for new equipment and for maintenance. Any improvement in the component field in terms of cost is significant to our economy.

In commercial electronics and communications, cost is naturally important to the customer. Because communications is ITT's business and because the corporation is versed in competitive commercial manufacture, operation and service, ITT is traditionally cost conscious. The same attitude is reflected in the many ITT activities in which the government is the customer.

An illustration of this is a new air layable cable for mobile warfare which ITT developed in conjunction with the U.S. Army Signal Research and Development Laboratory. Many technical requirements, difficult to achieve, were specified for this cable.

In addition to transmission requirements, it had to be capable of being airlaid, used on the ground, buried in the earth, submerged in water and used in aerial construction. There could not be an excessive increase in size and weight over cable performing a comparable job. The cable also had to meet specifications for easy storage and shipment while being rugged enough to need less maintenance and repair.

Working within these severe limits, a cable was developed which is similar in size, weight and flexibility to World War II field wire W11OB. It can be compared in some respects to Spiral-Four cable—but with some important differences. A four-fold increase in channel capacity has been achieved and weight and *cost* were cut in half!

Summing up, the communications and electronic business needs more reliable components, more components which permit designers to explore new concepts, and lowered costs all along the components line. These goals can be achieved. Failure to achieve them constitutes waste.

In his recent State of the Union message to Congress, President Eisenhower pointed out, "We can afford everything we clearly need, but we cannot afford one cent of waste."

That sentence might well be the theme of our efforts toward better components in the years to come.

The Age of Printed Circuitry

(*Continued from page* 40)

The greatest gain in consumption will be in the field of military electronics, with a sweep from a 4.4% of the 1957 market to 28.2% of the quintupled 1961 market. The air conditioning and appliance industries, currently using little or no printed circuitry, will account for much of the 1961 market.

In what specific products will printed circuits play a part? Because of the sizable 28.2% represented by military electronics, much of this information is classified.

Electric ranges, with their complicated pushbuttons, can and will be greatly simplified through the use of printed circuits.

Air conditioners will contain printed circuit components in such devices as remote control room thermostats.

Appliance timers, currently produced without printed circuitry at a rate of 15 million units annually, will ultimately utilize printed circuits extensively.

Automobiles will move to more extensive use of printed circuit wired front instrument panels. Some 1958 and 1959 autos are equipped with such a panel and many cars will install them within the next year or two. Two autos will use printed circuitry in the heater's servo-mechanism. Several bus and truck manufacturers are introducing printed wiring in voltage regulators.

Communications — dial phones, switchboards, automatic time-charge recording devices—will move to printed circuitry, although the bulk of this changeover is expected after 1961.

Computers—currently used in integrated data processing systems—will find their way into many diverse fields. They will control traffic flows; dispatch elevators in office buildings; control heating and air conditioning units and direct railroad freight classification yards. These developments will be possible sooner as a result of printed circuitry development.

Dictating machines, with their printed circuits and transistors, will become more compact and more portable.

Printed wiring will account for more compact, hence more economical color TV sets.

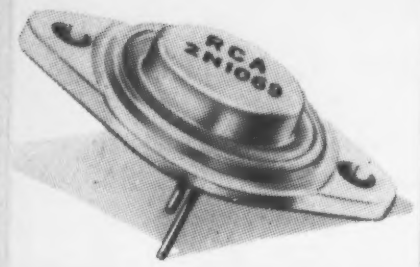
Printed circuits will be used extensively in built-in "hi-fi" intercommunications systems as plus-features in better homes.

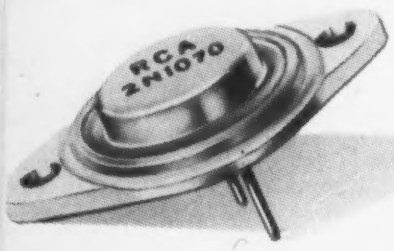
What are the advantages? Printed circuits are economical and more efficient. Once in production, they require less inspection and rejections are reduced. Servicing in the field is simplified; a new printed circuit board can be substituted for the old one in a few seconds. Production is speeded immeasurably and man hours are reduced. The once-familiar picture of workers bent over hot soldering irons is disappearing from electrical and electronic manufacturing.

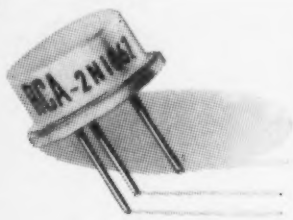
Beyond that, printed circuitry means miniaturization. TV screens are becoming larger, sets smaller. And in the field of missiles and rockets, miniaturization is of primary importance.

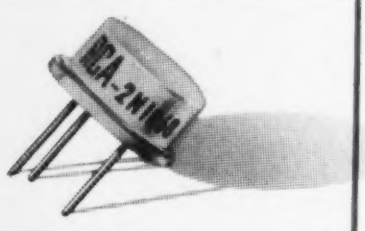
The values of printed circuitry are not limited to mass produced equipment, however. Printed circuits, in presenting such a high degree of reliability and superior electrical properties, will replace conventional wiring in low volume production units as well.

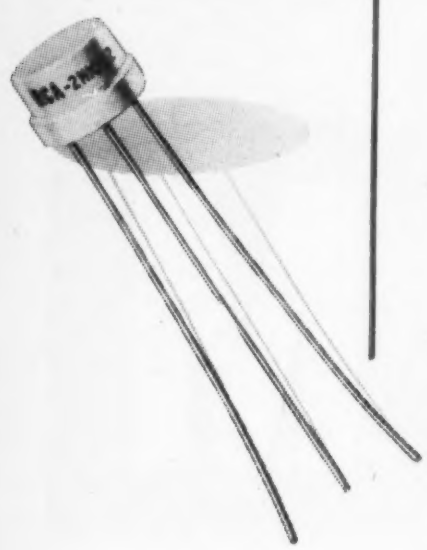
The Formica Corporation's study on printed circuitry may well prove conservative. Continued research and development probably will uncover many new uses.









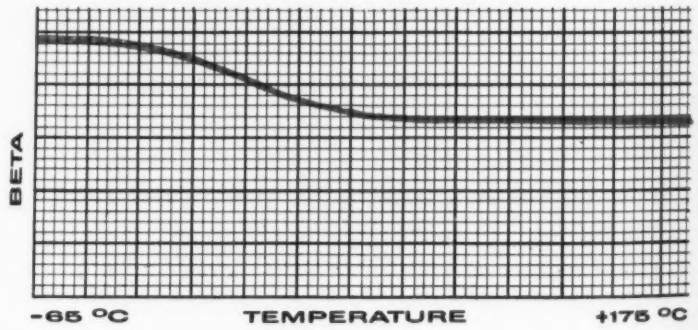


5 *new* RCA *Silicon Transistors*

DIFFUSED-JUNCTION MESA

...with excellent beta stability from −65°C to +175°C and exceptionally low saturation resistance!

- 2N1092—medium power
- 2N1067—intermediate power
- 2N1068—intermediate power
- 2N1069—high power
- 2N1070—high power



RCA's new n-p-n silicon transistors offer significant reductions in saturation resistance, and feature excellent beta stability over the entire operating temperature range. These features result from use of RCA's advanced diffused-junction mesa technique. These transistors are designed to meet stringent military environmental, mechanical, and life test requirements.

RCA silicon transistors offer the equipment designer a wide choice of power-switching capability in preferred industry cases (JEDEC TO-3, TO-8, and TO-9).

RCA SILICON TRANSISTORS are commercially available in limited quantities. Your RCA Field Representative has complete information on these units and will be glad to discuss with you other silicon transistors now under development. For technical data on the 2N1092, 2N1067, 2N1068, 2N1069, and 2N1070, write RCA Commercial Engineering, Section C-60-NN, Somerville, N. J.

Type	JEDEC Outline	ABSOLUTE-MAXIMUM RATINGS				CHARACTERISTICS								
						At Case Temperature of 25°C						At Case Temperature of 175°C		
						Saturation Resistance (ohms)			DC Current Gain (Beta)			DC Collector Cutoff Current (Icbo) (μa)		
		Vces● (volts)	Vceo▲ (volts)	Collector (amp.)	Transistor Dissip. # (watts)	Typical	Max.	Conditions	Typical	Min.	Conditions	Typical	Max.	Conditions
2N1092	TO-9	60	30	0.5	1	3	10	Ic=200 ma.	20	10	Ic=200 ma.	75	1000	Vcbo=30 volts
2N1067	TO-8■	60	30	0.5	2.5	3	10	Ic=200 ma.	35	15	Ic=200 ma.	75	1000	Vcbo=30 volts
2N1068	TO-8■	60	30	1.5	5	1	2.67	Ic=750 ma.	38	15	Ic=750 ma.	75	1000	Vcbo=30 volts
2N1069	TO-3	60	45	4	25	0.7	2	Ic=1.5 amp.	20	10	Ic=1.5 amp.	150	2000	Vcbo=30 volts
2N1070	TO-3	60	45	4	25	0.4	0.67	Ic=1.5 amp.	20	10	Ic=1.5 amp.	150	2000	Vcbo=30 volts

■ "Heat-Sink" mounting clamp supplied.
● Collector-to-emitter breakdown voltage with base connected to emitter.
▲ Collector-to-emitter breakdown voltage with base open.
At a case temperature of 100°C.

RADIO CORPORATION OF AMERICA
Semiconductor & Materials Division
Somerville, N. J.

EAST: 744 Broad St., Newark, N.J., HUmboldt 5-3900

NORTHEAST: 64 "A" Street, Needham Heights 94, Mass. HIllcrest 4-7200

EAST CENTRAL: 714 New Center Bldg., Detroit 2, Mich. TRinity 5-5600

CENTRAL: Suite 1154, Merchandise Mart Plaza Chicago, Ill. WHitehall 4-2900

WEST: 6355 E. Washington Blvd., Los Angeles, Calif. RAymond 3-8361

GOV'T: 224 N. Wilkinson St., Dayton, Ohio BAldwin 6-2366
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TECHNOLOGY and DEFENSE

by Deputy Secretary of Defense DONALD A. QUARLES

THE MAINTENANCE of a sound military posture so essential to deter Communist aggression has, for many years, relied critically upon the achievements of our scientists and engineers.

While all phases of science and engineering are involved in our tremendous research and development effort, I believe that the electrical engineering profession—particularly the relatively new *electronics* branch—is, percentagewise, the most heavily engaged in military work. In fact, statistics indicate that at least 60 per cent of all the electronics engineers in this country are now engaged in some degree in work on military programs. Because electronics looms so importantly in our technological race—our cold war struggle with the Communist nations—primary emphasis will be given in this presentation to the vitally important role electronics is playing in the creation of modern weapons.

It is not an exaggeration to say that most of the major new weapon systems available for use or under development today are completely dependent upon electronic devices for their successful operation. To forcefully illustrate this fact, we need only analyze a typical major new weapon system such as the F-106 all-weather interceptor aircraft.

As a weapon this aircraft would be completely ineffective if its fantastically complex electronic systems did not operate properly to provide communication, data link, identification, navigation and weapons control. The electronic devices in this aircraft employ over 1,000 vacuum tubes and 4,000 semiconductor devices. The development of the electronic systems required more than 1,000 man years of engineering effort and well in excess of $100 million. And this is not the whole story. To carry out its mission effectively, this interceptor, in addition to its complex airborne electronic equipments, depends on an extensive ground electronic environment of massive radars, digital computers and communication networks.

Antisubmarine warfare is another good example of an area where electronics has a key role. In fact, the great emphasis the Soviets have placed on their submarine fleet, numerically the largest ever assembled, makes it necessary for us to give very high priority to our antisubmarine warfare programs in which electronic research and development plays an essential part. When we see the spectacular performance of our own nuclear submarines, such as the *Nautilus, Skate* and *Seawolf*, and then consider the tremendous potential of ballistic missile firing Polaris type submarines, we realize how important it is for us to be able to detect and track such underwater targets when and if the Soviets develop and deploy weapon systems of this kind.

Still another area that is placing very heavy demands on our national resources in electronics is the defense against long-range ballistic missiles. The development of the new radars, computers and communications devices needed for an effective anti-ballistic-missile system probably presents one of the greatest technical challenges that electronics scientists and engineers have ever faced.

To complete the general picture, our rapidly growing programs in space are now demanding new levels of performance in electronic apparatus. We must develop new sensing and communication devices that can operate hundreds of miles above the earth for long periods of time—perhaps years — without interruption. The evolution of these devices, with the new power supplies and other electronic parts that are needed to meet the operational objectives, is certainly a formidable task. The problems of designing to meet space requirements—including light weight and the degree of equipment reliability demanded for satellite electronics —are perhaps more difficult than any previously associated with military electronics.

Many other examples could be cited, but I feel my point has already been made: The military capability of this nation, both today and as far as we can see in the future, is critically dependent upon electronics. Not only must these very complicated electronic systems work reliably, but they must do so in an environment of sophisticated hostile countermeasures designed to do everything possible to keep them from working.

This means that we must push forward the basic technology so that such complex and precise systems can be developed and engineered for economic production and for effective use by military personnel in a realistic service environment. It is difficult to say what level of scientific and engineering effort is needed to reach this objective, partly so because it is not an absolute goal but one that is relative to the accomplishments of an aggressive and resourceful competitor. Annual expenditures for development and production of military electronic devices have risen rapidly from around $750 million in 1951 to an estimated $4 billion in 1958. And as previously mentioned, this program already engages more than one-half of the nation's electronics engineers. It seems very likely that the future way will demand still further expansion of this effort.

(*Continued on page* 56)

FIGURE 1

highlights of the cold cathode tube development

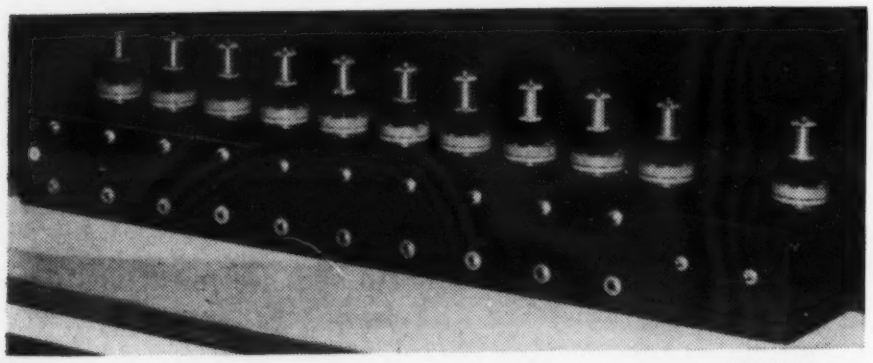


FIGURE 2

DR. ALFRED K. WRIGHT
Vice President
Operations and Engineering
Tung-Sol Electric Incorporated

by

DR. A. MELVIN SKELLETT
Director of Research
Tung-Sol Electric Incorporated

Figure 1. *A bank of new cool-running radio tubes that could revolutionize modern electronics is inspected by Dr. D. Dobischek, U. S. Army Signal Corps scientist who discovered the new cold cathode process. The tubes light up blue instead of red and run on one-tenth the power of ordinary tubes.* Figure 2. *Power for 10 cold cathodes = power for 1 hot cathode. Samples of a revolutionary new cold cathode electron tube, the first technological improvement in tube cathodes in 30 years.*

Dr. Wright

THIS article will introduce you to the new cold gasless cathode electron vacuum tube. This type of cathode was first discovered by Dr. D. Dobischek in the Signal Corps Laboratories at Ft. Monmouth, N. J. In July 1956, Tung-Sol started to develop and improve this cathode under contract to the U. S. Army Signal Corps.

One of its outstanding advantages, outside of the elimination of the heater, is the fact that unlike conventional vacuum tubes and transistors the working surface of the device is chemically and physically stable. This leads to the belief, and the facts so far substantiate this, that tubes using this cathode will display a degree of reliability and life not yet achieved by any known electronic amplifier.

As in all things, the tube is not an unmixed blessing. There are disadvantages, some of which can probably be overcome with further development and some of which may be fundamental.

In a recent news release from the Department of the Army, it was stated that ". . . the development of the new cool-running radio tube that glows blue instead of red and uses less than one-tenth the power of a standard hot cathode tube was considered to be the first major breakthrough in basic tube design in more than thirty years. The radically new tube may have as great an impact on electronics as the discovery of the transistor. It could be the forerunner of a new line of general-purpose tubes for broad military and civilian use.

"Development of this new experimental tube could have broad economic as well as scientific implications. It could also create a revolution in tube design by making possible the first reliable 'secondary emission multiplier'—potentially the world's highest gain amplifier tube. Until now, though, the secondary emission type of tube has generally failed because the hot cathode contaminated other elements in the glass envelope. By eliminating the hot cathode, the new tube solves this problem, and test models are under design.

"This reaction requires a barely perceptible amount of electricity. A cold cathode tube can idle on 5 millionths of a watt, a tremendous saving over standard tubes. Future designs should be more efficient.

"The new tube also springs to life as soon as it is turned on, while an ordinary tube requires several seconds for warm-up.

"Like the discovery of vulcanization and the X-ray, the new tube principle was discovered by accident. While experimenting on field-enhanced secondary emission, Dr. Dobischek noticed that one of his experimental tubes kept running even though he turned off the primary current. After years of research at the U. S. Army Signal Research and Development Laboratory's Techniques Branch, he perfected a surface that would continue to emit electrons indefinitely.

"The Army sees the possibility that this discovery will lead to even smaller, faster-acting walkie-talkies and simplified design of other communications gear where the heat generated by conventional tubes poses serious problems.

"The new tube, like other electron tubes, is extremely resistant to heat and atomic radiation, important in military equipment which must withstand exposure to a nuclear blast or the searing heat of a missile nose-cone."

Dr. Skellett

I am quite certain that many of the readers of SIGNAL Magazine may be as thoroughly familiar with electronic terminology as I am. However, I am going to ask that you bear with me through a very elementary description. I want to describe this new device in the very simplest terms, so that all of you from your different viewpoints, will get a clearer picture of the implications of the cold cathode vacuum tube development.

(*Continued on page* 62)

the services of ARINC research corp.

by
C. R. KNIGHT, Director, ARINC Research Corp.

ARINC Research Corporation traces it origin to the ever growing need for reliability in the critically important field of electronics.

Established in 1951 as a department of Aeronautical Radio, Inc.—the airline affiliate known more commonly as "ARINC"—the organization has until recently supplied reliability consultation services only to the military services. Activation of the new corporation enables ARINC to share with all interested organizations, commercial as well as military, its unique experience in the systematic scientific study of reliability.*

Prime mover in ARINC's venture into the commercial field was the increasing importance of reliability to industrial users of electronics. Reliability is a major factor in determining how rapidly industry can convert to automation and apply other electronic techniques that are now available or in development. As production methods become more and more complex, and as reliability becomes a specified characteristic of equipments, there will be increasing demand for the services of an organization with a feel for the problems involved, and with the procedural and technical knowledge required to solve such problems.

The background of the present work of ARINC Research Corporation reflects a great deal of technological history compressed into a surprisingly brief span of years. By the end of World War II, the use of electronic devices for airline navigation and communication had greatly increased, and more improvements were on the way. However, it was apparent that the newly developed equipments would be of doubtful value unless the failure rate of electron tubes could be drastically reduced. There were, of course, other causes of equipment failure, but tubes were unquestionably the major cause. At that time, they were responsible for 75 per cent of all failures of airborne electronic equipment.

To find solutions to this critical problem, ARINC in 1946 began a tube-improvement program for the commercial airlines. Initial effort was concentrated on ten tube types capable of performing most of the functions required in airborne communication and navigation equipments. Through the systematic collection and analysis of data, and with the cooperation of the airlines and tube manufacturers, ARINC sponsored development of a series of improved tube types which were put into general use in commercial airline equipments in 1950. Within four years of the beginning of this program, it was estimated that the new tube types were saving the airlines over a million dollars a year in replacement and maintenance costs alone.

On the strength of the success of the airline tube-improvement program, ARINC was requested by the Department of Defense to study the reliability of electron tubes in military applications. This effort, begun in 1951, has spanned a period during which the failure rates of tubes in military equipments have decreased by as much as 10-to-1, and slow deterioration has become the dominant cause of tube failure. The extent to which deterioration now influences the life of tubes used in various types of military electronic equipments is shown in Figure 1. This generalized picture also indicates the importance of application and maintenance problems in complex equipments and systems used in severe environments. As the military tube problem has diminished, ARINC's research program has expanded to include the study of systems used for many different purposes in such vastly differing environments as: B-52 Stratofortress, Honest John Rocket and *U.S.S. Forrestal*. Throughout this period, the ultimate goal of all activity has been to discover means of defining, measuring, predicting and improving electronic reliability—a reliability which, among other things, depends on the operational efficiency of components.

At this stage in its history—after a decade of exploratory effort in several fields—the organization considers its major contribution to reliability engineering to be the development and practical application of new methods for approaching

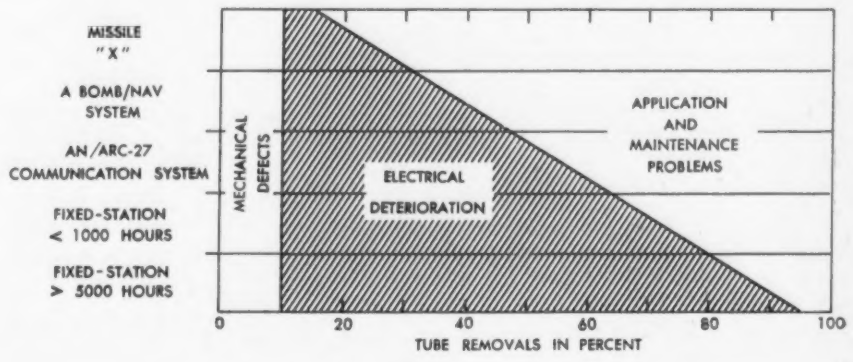


FIGURE 1

the reliability problem. Specifically, some of these are:

(1) Techniques for measuring equipment reliability in the field.

(2) Statistical techniques for designing reliability experiments and interpreting the results.

(3) Techniques for predicting the reliability of an equipment type.

(4) Techniques for analyzing the complex interactions among components of a system and the effects of these interactions on system performance. (These are known as "multivariate analysis" techniques.)

At present, major emphasis is on the development of techniques which will accurately predict the reliability of a system from information available prior to production—for example, at the drawing-board design stage. ARINC's first efforts in this direction were made several years ago in connection with the Air Force Reliability Assurance Program. By means of a technique based on failure-rate information, the reliability of a bombing/navigation system was predicted from the part level upward, and the predictions were compared with results obtained in field testing.

The following table gives the ratio of predicted to observed mean time-between-failures for the system as a whole and for three subsystems:

	Predicted Value / Observed Value	95% Confidence Limits on Observed Data
Bombing/Navigation System	1.92	1.70 — 2.10
Computer Subsystem	0.80	0.78 — 0.90
Radar Data-Presentation Subsystem	0.94	0.85 — 1.05
Radar Subsystem	4.45	3.90 — 5.00

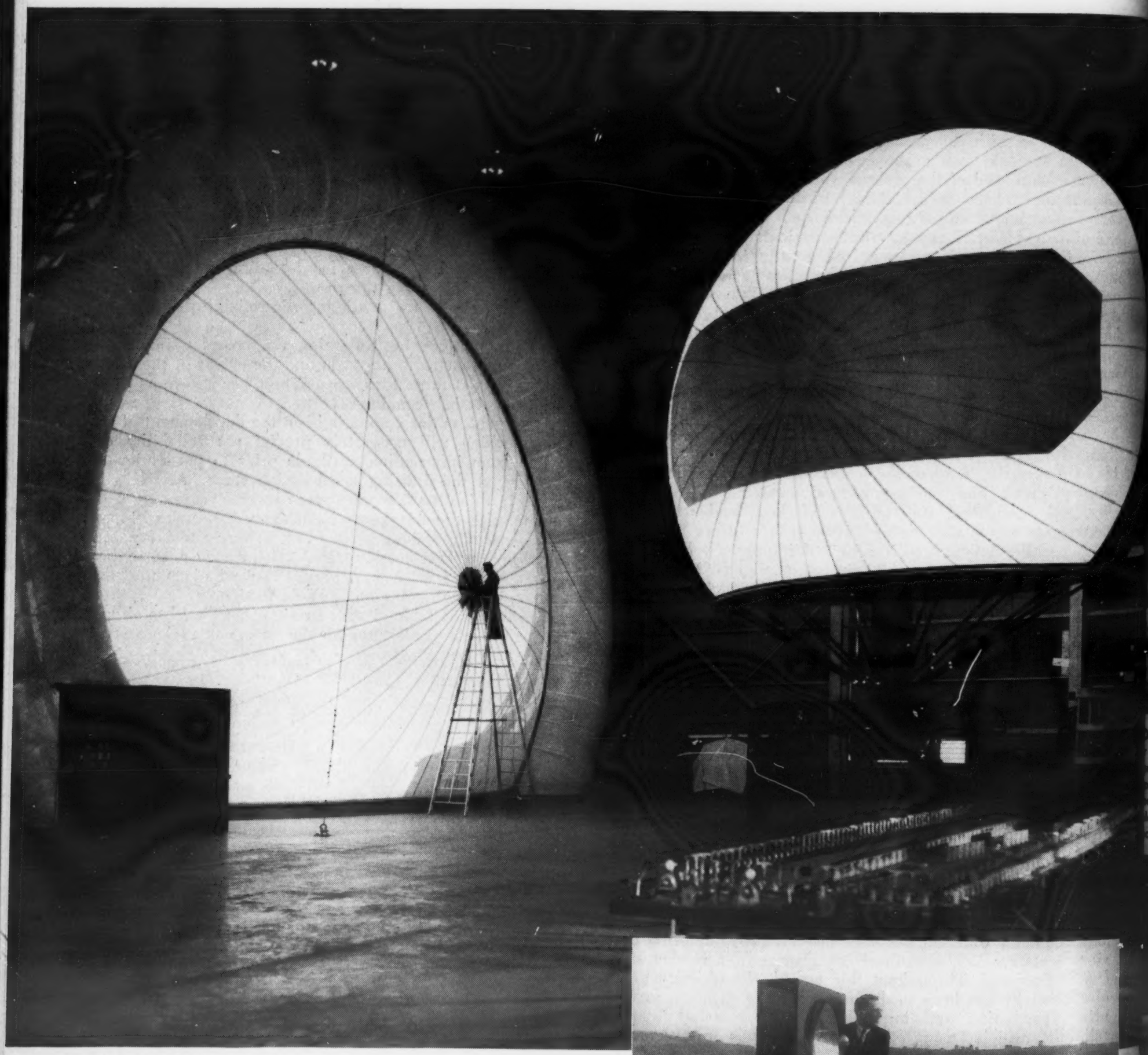
The rather high ratio of 2-to-1 for the system is due almost entirely to the fact that a serious error was made in predicting the reliability of the radar subsystem. On the assumption that electronic units would cause most of the trouble in the radar, ARINC grossly underestimated the trouble which would be caused by electro-mechanical units.

The extremely good results obtained in the case of the computer and radar data-presentation subsystems were matched later in a verification test involving the AN/ARC-27 communications system. Predictions for the receiver-transmitter unit of this system were made by a method based on a single failure rate for all tubes and by a method based on the failure rates of tubes used in this unit. In the first case, the ratio of predicted to observed mean time-between-

(*Continued on page* 54)

*The new corporation is a wholly-owned subsidiary of Aeronautical Radio, Inc. Mr. J. S. Anderson and Mr. R. J. Gleason, are president and vice president, respectively, of both corporations.

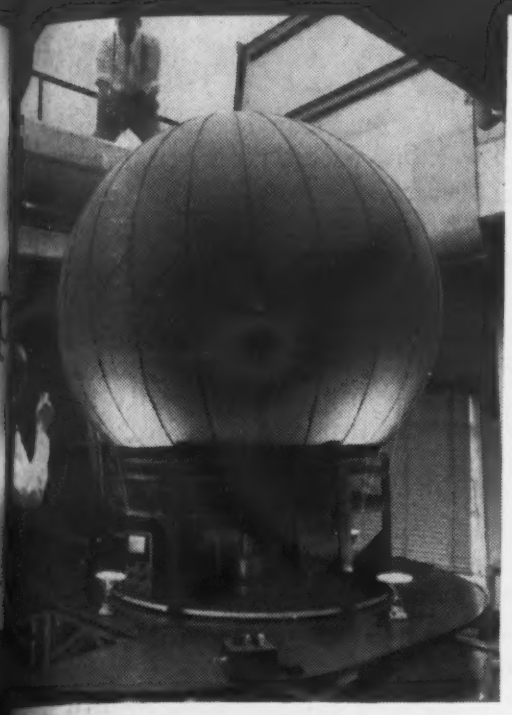
Westinghouse With 25 Years Of Leadershi Is Meeting Today's Detection Problems



Westinghouse has been in the radar field since 1933. In that year, Westinghouse engineers, pioneering in radar techniques, detected automobiles on a highway by beaming ultra short radio waves experimentally off a rooftop of the Westinghouse East Pittsburgh Plant (illustrated at right).

Westinghouse has delivered over 35,000 radar sets . . . and continues its role today in ground and shipboard radar for air defense and tactical missions, airborne radar for reconnaissance, AEW, mapping, ASW and missiles, and such specialized areas as pulse-doppler, infra-red, ECCM, and 3-D radar techniques.

Shown is one of the most significant advances in the field of tactical military equipment—the lightweight, highly mobile Paraballoon® Antenna, developed at the ***Electronics Division.***



ROTATING ANTENNA. A new kind of ar antenna, the Helisphere is considered a ible forerunner of those to be used for erful antimissile radars of the future. The nna, pictured at the Westinghouse ***Research oratories,*** produces a rotating radar beam out rotation of the antenna structure itself.

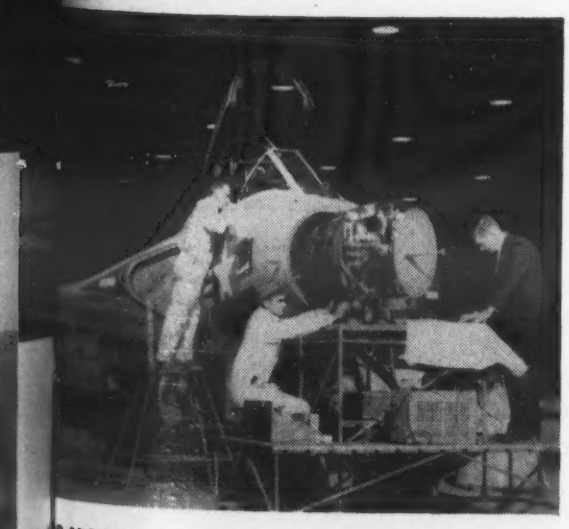
INFRA-RED. Westinghouse has been actively at work in infra-red research, design and development since World War II. Extensive programs are now being conducted for applications of infra-red techniques to present and future military requirements as well as the space age. Pictured is an infra-red seeker, newly designed at Westinghouse ***Air Arm Division.***

BIGGEST RADAR TUBE. Heart of the longest range shi borne radar ever put in service, a magnetron tube ni named "Big Maggie" was developed at the Westinghou ***Electronic Tube Plant*** at Elmira. "Big Maggie" delive over 10 million watts of peak power, enough to search a enemy planes over 400 miles away.

LECULAR SYSTEMS. A new, low-noise ampli- developed by scientists at Westinghouse *earch Laboratories* for ***Air Arm Division*** ap- ation. This two level solid-state maser is one ct of a broad Westinghouse program of lecular engineering for radar and other tronic systems of the future.

WORLDWIDE SERVICE. Wherever Westinghouse radar is in operation . . . land, sea and air . . . field engineers of the ***Electronics Service Department*** assist and instruct in the operation and servicing of radar manufactured by the ***Air Arm*** and ***Electronics Divisions.*** Graduate engineers provide this Westinghouse service the world over.

COMPLETE TEST FACILITIES. Radar undergoes composit test at ***Electronics Division.*** A complete computer facili is available here and at ***Air Arm Division.*** Included a IBM 704 and large REAC, together with all environmenta shock, vibration and other test equipment necessary f the development of present and contemplated land, se air and space-borne systems.



0-MAN FLIGHT TEST FACILITY. Engineers at ***r Arm Division*** install Aero 13-F radar and mputer, latest and most advanced radar built Westinghouse. Flight test facility includes er 200 people and all facilities necessary to mpletely service, instrument and test avionic ipment in Westinghouse owned and bailed

For additional information on detection systems and applications at Westinghouse, write to:

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failures was .863. In the second case, the ratio was .897. It is anticipated that equally good results will be obtained in a current series of tests involving the bombing/navigation system mentioned above and a new airborne communication system.

In a separate program under government sponsorship, the Corporation is working on the development of prediction methods suitable for application to guided missiles. Missile systems, of course, present some unique problems not encountered in the more conventional airborne and fixed-station equipments—for example, severe environmental problems which are difficult to simulate accurately in the laboratory. In an effort to solve some of these problems, the Corporation has undertaken an intensive study of component parts, to determine how rapidly part characteristics deteriorate under various levels of environmental stress, how the characteristics combine to give system characteristics, and how well they satisfy the user. As the information derived from this study is fed back to designers of parts and equipments, it contributes to the improvement of specifications and production processes, as well as of the products themselves. These subsidiary effects of the feed-back process may, in the long run, prove as valuable to the buyer as the ability to predict system reliability in advance of field use.

While some electronics producers already have their own staffs of specialists working on reliability improvement, many others must take up the complex problems of reliability with little or no experience in this field, or with insufficent equipment or trained personnel to carry out the elaborate investigations frequently required. Still others may have chronic problems which cannot be solved or even thoroughly explored without the diversion of necessary manpower from other more urgent work. For such organizations, a consulting organization like ARINC Research Corporation provides a variety of services in several important areas.

One type of service involves assistance to the manufacturer in evaluating system design and solving reliability problems early in the design stage, as well as in planning and carrying out laboratory and field evaluation of system reliability. At the present time, the Corporation is under contract to a producer of a ground-support equipment to establish reliability requirements and suitable methods for predicting the reliability of the equipment. Another project involves the development of reliability-prediction methods for application to Naval Ordnance weapons, such as missiles and torpedoes.

Consultation services are available to those manufacturers who desire to establish their own programs for measuring reliability and analyzing data. In a recent cooperative study designed to evaluate the effectiveness of certain inspection procedures, the changes made as a result of the evaluation have been instrumental in saving the military services millions of dollars in unnecessary and often detrimental test methods.

Associated with the type of service just mentioned is that provided to equipment manufacturers who desire aid in the preparation of specifications for parts and components, and in the evaluation of the performance and reliability of these products. The Corporation is able to draw on several years of experience in the development of specification methods and in the preparation of application manuals for receiving tubes, transmitting tubes and transistors—which are being published under Department of Defense sponsorship for distribution to designers and producers of electronic products.

One other important type of service which should be mentioned is the training of engineers and production supervisors of client concerns in the fundamental concepts of reliability and in practical methods of improving reliability.

While the foregoing statements indicate that the type of services offered would probably be of greatest value to persons totally unfamiliar with the field of reliability, it is interesting to note—to the contrary—that the Corporation's early contracts were made with equipment manufacturers who are considered to be leaders in the field of reliability improvement. The reason for this apparent anomaly is quite simple: organizations which have devoted considerable time and attention to reliability tend to know where their problems lie, which problems they can best solve on their own, and which problems can best be handled with outside help. Moreover, management personnel in these companies are very reliability-conscious, and are interested in taking the steps required to advance their position in this field quickly.

The diversification of specialities within ARINC Research Corporation makes it most desirable that all services be corporate rather than individual. In this manner, without overstaffing, the skills of various personnel can be brought to bear on particular problems as the need arises. Such consulting services may require only three or four men's time, but may draw from the experience of the entire staff. Programs of this type can best be carried out through task-type contracts which clearly place the responsibility for proper performance on the corporation.

Research services of the 120-man staff are provided by five groups of technical and professional personnel who report, through their division managers, to the Office of the Director.

The planning and conducting of field tests and the analysis of data resulting from such tests are the responsibility of three engineering divisions whose personnel reflect a wide range of training and experience. Most familiar with field problems, by virtue of their function as liaison personnel, are the field engineers and technicians who supervise and man the ARINC bases at military installations. In the course of conducting field tests, these personnel spot trouble areas and make direct recommendations to the military services concerning changes in application or procedure which may effect large savings in time and money.

Research and application-engineering functions are performed by two other engineering divisions. Project engineers and statisticians in these divisions have prime responsibility for designing the controlled tests conducted by the corporation, and also for the analysis, evaluation, and formal reporting of the results obtained. For example, a test is being conducted aboard the *U.S.S. Forrestal* to determine the effect of cycling on the reliability of the ship's electronic systems.

A fourth group of personnel, the Engineering Services Division, was set up to release enginers and statisticians for creative work in their special fields. This division has complete laboratory, data-processing, and publishing facilities, and supplies other divisions and the parent company with a wide range of "back-stopping" services. These include the testing of electronic devices and the design of special test circuits, the computing and machine processing of all types of data, and the editing and preparation of all corporation reports. That the corporation is able to handle numerous broad investigations simultaneously is due in large measure to the extensive support provided by this division.

Serving as advisors to all the groups mentioned above are the Consultant Group—four highly trained specialists whose fields include engineering, statistics, operations research and econometrics. These men provide guidance in the theories, policies and techniques of reliability investigation, and are responsible for establishing new and advanced technical methods to be applied by the engineering divisions. At the present time, the Consultants are preparing a report on a method for optimizing reliability and maintainability to achieve minimum cost. In view of the vast sums now spent in maintenance each year, the dollar saving made possible by this study could be extremely high.

The fact that a method, rather than a product, is the end result of the study mentioned above serves to emphasize the point made earlier in the article—namely, that ARINC Research Corporation has concentrated on the development of methods for approaching and solving reliability problems. While much of this research has been done for the armed forces, the services of the Corporation are by no means limited to the military area, or to the field of electronics. The type of knowledge available is as valid in one field as in another; it can be applied successfully wherever reliability problems occur.

Tools of the Space Age

(*Continued from page* 32)

destined for the 1960 Army. The set has 920 crystal controlled channels for transmitting and receiving and an auxiliary receiver. It weighs 15 pounds, is fully subminiaturized, and has a density of about 6,000 parts per cubic foot. However, the same set in micro-module form would be reduced to five pounds, with a size reduction of approximately 20 to one. Half of the circuitry in this piece of equipment has already been micro-modularized and the job will be completed in the near future.

Another interesting example is a digital computer of the type used in a missile. A packaging arrangement is under development which will have 8,000 parts and occupy a space only 2" by 4" by 5". It will be hermetically sealed in a can with a connector head on one end, so that it can be inserted or removed instantly. With a simple "go, no-go" indicator the computer will be checked in a moment and replaced in a few seconds if necessary.

In addition to these size, weight and efficiency factors, it is important to realize that micro-module construction will improve the reliability of Space Age electronic systems. As these devices become more compact, their mechanical ruggedness increases. Micro-modularized equipment is highly tolerant of shock and vibration. Through automated production techniques, human errors in assembly are reduced. Through circuit standardization—a by-product of simplified modularized design—it is possible to use a single module for many different functions and in different types of equipment. In addition, where absolute reliability is required, it becomes possible to provide duplication of circuits with automatic switch-over or parallel operation.

The prime objective of military maintenance is to reduce equipment "down time" to a minimum. Here, too, modular construction makes its contribution. The soundness of maintenance by "replacement and discard" is frequently indicated by studies analyzing the factors of operator training, logistics and cost.

In logistics, particularly, it can be demonstrated that micro-modules offer startling improvements. A few years from now, when modularized equipment will be common, field depots and spare parts inventories will not have to contain millions of discrete types, sizes and shapes of parts. Instead there will be a relatively few basic micro-modules, easily replaceable with a minimum of servicing time and skill. Reducing the number of items in inventory and simplifying the training requirements for maintenance personnel will bring a significant reduction in the military budget required to maintain equipment in the field.

There is an acute awareness of the need for much shorter development cycles in our defense program. It now takes five years or more from the conception of an idea to its production as usable hardware. This time lag should be appreciably shortened by the standardization offered by micro-modules. Circuit standardization will bring about a reduction in design time. Equally important, automation of production of more and more parts will mean that actual production time will be reduced, as well as the time required to assemble the modules into finished pieces of equipment.

Along with increased dependability and adaptability, easier maintenance and more efficient production, it is evident that the micro-module concept offers a means to reduce costs. The initial cost of electronic equipment will be lowered because of the advantages inherent in standardizing —or eliminating—many engineering and production processes. The basic cost of material, and the assembly and testing of modules, will be less than that of today's components.

In addition, the micro-module design concept has the advantage of compatibility. Existing components representing the present state of the art, can be readily adapted for use with micro-modules. At the same time the micro-module concept will accept readily the materials and process of tomorrow. Thus, it offers a direct road to the advanced art of the future.

This is a program which requires the skills of the entire electronics industry, and which will lead to a logical conversion in both the military and commercial fields. Many segments of the components industry have already made significant contributions to progress in the field. This must continue at an accelerated pace, for our nation's military techniques depend on our ability to stay ahead in electronics. And in this effort the micro-module represents more than a hopeful gleam in a scientist's eye. It is the next practical step forward in the steady march of electronic progress.

Possibility or Capability

(*Continued from page* 30)

tropospheric scatter communication in day-to-day operation and is handling operational and administrative traffic over it.

This does not mean that its state of development is as far advanced as the missile systems which guard Philadelphia, or that every outfit in the Army will have a scatter system next year. This technique is, however, much further along in its evolution than the more glamorous "moon bounce" technique previously mentioned.

The mere fact that these over-the-horizon techniques are in use today does mean that we *can* have the long haul communications required for the vast distances over which missile equipped armies of the future must operate. Development of prototype systems for the field Army is in progress, but we do not have it today.

In the humble opinion of this writer there is a danger to the country if the public's whole attention is drawn to futuristic developments to the point where we lose sight of our "in being" *present* capabilities. We should, therefore, place new developments in their proper perspective as to time frame. If we do not, we may cause the American people to lose sight of our needs of today by keeping their attention too firmly focused on possibilities of the future.

There is too small a distinction made these days between *possibility* and *capability*. At times, advertising claims made for products having military application in some instances have a tendency to confuse the public as to what is here and what is still around the corner.

As we look to future possibilities, let us not neglect improving and increasing our existing capabilities. Our capabilities *in being* are important too.

Some remaining steps between possibility and capability are necessary for adequate command control even of our present field Army.

To insure control in the future Army and to improve control of our weapons in being, these steps must be taken as rapidly as possible.

Let us exploit any technique or device which improves our present mode of operation. Let us be prepared to take advantage of breakthroughs when they occur. But let us not get too much in the habit of "staring off into space." Some of us must keep our eyes on our everyday surroundings with a view to improving control of what we now have in being for on-the-minute preparedness.

Technology and Defense

(*Continued from page* 49)

All of this raises the spectre of a possible future shortage of creative technical people in this field, and indeed in a number of other key areas of technology. To maintain our technological leadership we will have to discover ways to insure a maximum contribution to the nation by every engineer and scientist, whether his activities are military or civilian. This means that the management of all our research and engineering programs must take utmost care to see that the services of technical people are employed to maximum effectiveness.

In the Department of Defense there is an acute awareness of the need for improving the direction and management of our research and development work, not merely to conserve dollars, but to gain for us a greater return in research and development output from our precious technical resources. We must be careful here to keep our values straight. Turning out new things fast is not necessarily a measure of progress. Too frequent replacement of one weapon by another is militarily inefficient. It is the well-planned big steps that pay off. The real test is how big is the improvement at the time it becomes available, and not necessarily how quickly can something new be turned out. Reducing lead time on the big improvement is nevertheless vital and calls for the best possible management of our resources.

To further expand the free world technological potential, the Department of Defense is cooperating very closely with our NATO and other allies in military research and development. This promises to be especially profitable in the field of electronics because some of these friendly countries have very advanced technologies in this area.

USSR Challenge

In spite of the steps that are being taken to increase the numbers of our engineers and scientists and to make more effective use of those available both here and abroad, we face a real challenge in keeping pace with future Russian progress in electronics.

Right now, our position with respect to the Soviets in electronics is probably more favorable than in some other areas. But they have recently made very swift progress in electronics, and they are continuing to expand their efforts in this as well as other militarily important fields. It is clear that we are in a technical race and that we have a strong and determined competitor in areas of importance to national security.

There are many other aspects of the Communist threat which are even more immediate than this technological challenge we have been talking about. First and foremost, their build-up of atomic weapons and advanced systems of delivery expose us to the devastation of an all-out nuclear attack. Technically speaking, there appears to be no completely satisfactory defensive screen that can shield us from the devastation of such an attack so our fundamental reliance must be upon a deterrent retaliatory position that will convince an aggressor that he would have to pay a completely unacceptable price for his aggression. For this deterrent position to be sound and adequate, we must have not only the striking forces for retaliation but also the means of detecting a surprise attack before it hits us so our striking forces can be alerted, and we must have a continental air defense system which will, if not stop the attack, at least blunt the blow so as to insure the effective survival of the retaliatory forces. Maintaining this deterrence is our prime security requirement. Our military leaders agree that we have such a position today. The problem is to maintain it in the face of ballistic missile developments and the other very rapid changes in technique that are taking place.

Balanced Program

There is, of course, another aspect of the program that we must keep in mind, namely that while being prepared for the immediate showdown we must also be prepared for the long pull, recognizing that the aggressor can choose the timing. This makes it clear that stability and a vigorous national economy are necessary ingredients of national security in a long-range sense. Our problem is to maintain a balanced security program which satisfactorily meets all these requirements. I believe that our present programs constitute such a balance.

One hears criticism of this program to the effect that it is inadequate to meet the Soviet challenge and that a so-called "gap" will open up in the years immediately ahead as long-range ballistic missiles become operationally available. I see nothing in the situation today or the situation that we must expect in the future that will open up any such gap. This requires, of course, that we carry forward our present programs with a continuing sense of urgency. There is certainly no place in the picture for complacency, but there is also no place for defeatism or despair.

Fundamentally, this question of the soundness of our position is a professional military question . . . for a specific appraisal we might turn to the Chairman of the Joint Chiefs of Staff, General Nathan F. Twining, who said in a speech in Washington last September: "Well, how do we stand? The Soviets outnumber us in divisions and submarines. They are probably ahead of us in the development—and I stress the word development—of long-range missiles. But relative military strength does not depend on numbers alone or on developmental progress. Considering our superior strategic retaliatory power, our flexible and mobile tactical power, our industrial prowess, and our economic strength, I say in full confidence that we are militarily superior over-all to the Soviet Union today, I see no reason why, with concentrated effort and good judgment, we should not be superior in the 1960's as well. I earnestly hope that the American people will remain aware of the very serious multi-pronged threat which faces the United States and that they *will* devote the necessary concentrated effort to meeting the challenge and maintaining the freedom of our country. I fully expect America to live up to this hope and eliminate any cause for pessimistic gloom."

Let me say that I, too. fully expect America to live up to this hope. Our position will be challenged, our motives will be maligned. The policy of deterrence is the policy of non-agression—of peace. But paradoxically, deterrence can only be effective, can only carry the conviction that will indeed deter, if we stand firm under stress wherever the Communists may probe and however violent the language they may use.

Admittedly, we would all like a less precarious and less demanding system of peace and security. Certainly we must strive urgently and honestly for such a system, through the United Nations or any other effective mechanism that may present itself. But until we have a reliable substitute we must be sure to preserve the system we now have—a security posture based on the disavowal of aggression and indeed of aggressive aims, but based too on such strength and determination as to make aggression against against us completely unattractive.

Standing with our free world friends this, I believe, we can do. This, I believe, we will do.

THERE'S A PHILCO TRANSISTOR FOR EACH OF YOUR CIRCUIT REQUIREMENTS

SURFACE BARRIER TRANSISTORS (SBT*)

TYPE	GAIN h_{fe}	FREQUENCY f_{max} in mc	APPLICATIONS
2N128	40	60	General communications; MIL specifications
2N240	30	Switching rates 20mc	High-speed switch; controlled hole storage and saturation characteristics; MIL specifications
2N299	22db @ 10mc	110	Tuned amplifier; MIL specifications
2N300	18	95	Video amplifier; MIL specifications
2N344	22	50	General purpose; narrow beta spread (11-33)
2N345	35	50	General purpose; similar to 2N344 with higher beta; MIL specifications
2N346	20	75	General purpose; like 2N344 and 2N345 but higher frequency
SB100	20	45	General purpose amplifier

*Trademark Philco Corp. for Surface Barrier Transistor

MICRO ALLOY TRANSISTORS (MAT*)

TYPE	GAIN h_{FE}	FREQUENCY f_{max} in mc	APPLICATIONS
2N393	95	60	High-speed, high-gain switch; MIL specifications
2N1122	95	60	High-speed, high-voltage level switch
2N1122A	95	60	Higher voltage level operation

*Trademark Philco Corp. for Micro Alloy Transistor

MICRO ALLOY DIFFUSED-BASE TRANSISTORS (MADT*)

TYPE	GAIN	FREQUENCY f_{max} in mc	APPLICATIONS
2N499	10db @ 100mc	320	VHF amplifier; MIL specifications
2N500	22mw PO @ 200mc	400	VHF oscillator; MIL specifications
2N501	h_{FE} 35	Switching rates 40mc	Ultra-fast switch; typical t_r 9μsec; t_s 9μsec; t_f 7μsec; MIL specifications
2N501A	h_{FE} 35	Switching rates 40mc	Rated at 100°C; MIL specifications
2N502	10db @ 200 mc	700	VHF amplifier; MIL specifications
2N502A	10db @ 200 mc	700	Rated at 100°C; MIL specifications
2N503	12.5db @ 100mc	420	VHF amplifier
2N504	46db @ 455kc	Minimum 50	IF amplifier; high level logic switch
2N588	14db @ 50mc	250	General purpose RF-IF amplifier

*Trademark Philco Corp. for Micro Alloy Diffused-base Transistor

MICRO-MINIATURE TRANSISTORS

TYPE	GAIN h_{fe}	FREQUENCY $f_{\alpha b}$ in mc	APPLICATIONS
2N207	100	2	Low level amplifier; particularly suited for hearing aid use; N.F.* 15db max
2N207A	100	2	Low level amplifier; particularly suited for hearing aid use; N.F.* 10db max
2N207B	100	2	Hearing aid input stage; other extremely low noise applications; N.F.* 5db max
2N534	150		High voltage amplifier switch
2N535	100	2	General purpose; 85°C max temperature rating; N.F.* 10db max
2N535A	100	2	General purpose; 85°C max temperature rating; N.F.* 5db max
2N535B	100	2	General purpose; 85°C max temperature rating; N.F.* 0db max
2N536	h_{FE} 100	2	Low level switch at pulse rates up to 150kc

*Noise Factor at 1μv reference level across 1000 ohms

SILICON ALLOY TRANSISTORS (SAT*)

TYPE	GAIN h_{fe}	FREQUENCY f_{max} 15mc	APPLICATIONS
2N495	15		General purpose; MIL specifications
2N496	h_{FE} 10	f_T 11mc**	High-speed switching; MIL specifications

*Trademark Philco Corp. for Silicon Alloy Transistor **Frequency for beta=1

BILATERAL TRANSISTOR

TYPE	GAIN h_{FE}*	FREQUENCY $f_{\alpha b}$ 500kc	APPLICATIONS
2N462	45		Controlled pulse response (max t_{on} and t_{off} 12μsec)

*Forward and inverse

POWER TRANSISTORS

TYPE	GAIN	FREQUENCY $f_{\alpha e}$ in kc	APPLICATIONS
2N386	33db @ 5w PO	Minimum 7	High-voltage general purpose amplifiers; relay actuators and power converters
2N387	33db @ 5w PO	Minimum 6	High-voltage general purpose amplifiers; relay actuators and power converters

MEDIUM FREQUENCY TRANSISTORS

TYPE	GAIN h_{FE}	FREQUENCY $f_{\alpha b}$ in mc	APPLICATIONS
2N597	70	4.5	High-voltage general purpose amplifier and switch; TO-9 case
2N598	85	7.5	500kc logic switching; TO-9 case
2N599	105	18	Logic switching rates up to 1mc; core driver; TO-9 case
2N600	85	7.5	500kc switching; 1 watt peak power dissipation for 0.1 sec; stud mount
2N601	105	18	High-power core driver; typical rise time 0.1 μsec; stud mount
2N1123	70	4.5	High-voltage power amplifier and switch; stud mount

PULSE AMPLIFIER TRANSISTORS

TYPE	GAIN $\frac{h_{FE}}{h_{fe}}$	FREQUENCY	APPLICATIONS
2N670	100	$f_{\alpha b}$ 700kc	High peak current pulse amplifier; relay driver
2N671	100	$f_{\alpha b}$ 650kc	High power version of 2N670; stud mount
2N672	20 (Sat.)	0.5 μsec max t_r	High-current switching core driver; controlled rise, fall, and storage times
2N673	20 (Sat.)	0.5 μsec max t_r	High power version of 2N672; stud mount

MEDIUM POWER TRANSISTORS

TYPE	GAIN $\frac{h_{FE}}{h_{fe}}$	FREQUENCY $f_{\alpha b}$ in mc	APPLICATIONS
2N223	110	0.6	Audio driver; exceptional beta linearity
2N224	90	0.51	Audio output; exceptional beta linearity; available as matched pair (2N225)
2N226	60	0.4	Audio output; exceptional beta linearity; available as matched pair (2N227)
2N1124	Min $\frac{h_{FE}}{h_{fe}}$ 40	Minimum 0.4	E3-51 based high-voltage, general purpose industrial amplifier
2N1125	100	Minimum 1	E3-51 based high-voltage, medium frequency amplifier and switch
2N1126	Min h_{fe} 40	Minimum 0.4	E3-51 based high-power, high-voltage, general purpose industrial amplifier; stud mount
2N1127	100	Minimum 1	E3-51 based high-power, high-voltage, medium frequency amplifier and switch; stud mount
2N1128	100	1	E3-51 based audio driver
2N1129	165	0.75	E3-51 based high gain transistor for amplifier and switching
2N1130	125	0.75	E3-51 based general purpose audio transistor

PHILCO® CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

(*Continued from page* 37)

somewhat greater than most large-scale commercial computers can handle. It is called MOBIDIC.

MOBIDIC is a solid-state processor, completely militarized, capable of operating under all conditions to which an army may be exposed. The first MOBIDIC will be delivered to us within the coming year. Others, using the same components, will be developed for lower echelons and will be available for field tests within two years.

Of even greater importance than the equipment development is the very expensive Army program of application studies being conducted by all of our major combat, intelligence and logistical centers to determine what electronic data processing system techniques can do to provide new capabilities in both the tactical and logistical decision-making fields.

I might say in referring to this important subject that the Army's experience in exploiting data processing parallels that of industry. We also have learned that management understanding and inhouse personnel education and development are the indispensable requirements for successful exploitation of automation.

Another major systems problem in the Army's over-all command control system is that of target acquisition, information-gathering and intelligence evaluation and display. Many new sensory devices such as radar, infrared, photography and television are being employed in Army aircraft, in drones, and in ground-based elements. Under this systems concept (Figure 4), the data they pick up is reported back to the commander's surveillance center and provides inputs to previously stored data. The intelligence, or G-2 staff, will then have available up-dated programs to keep them abreast of the over-all military situation confronting the commander.

The next logical step in the command control system is to provide a scientifically-designed management environment for the commander which utilizes the latest in technical means and human engineering. It is the final payoff for all tactical electronic systems which have previously been discussed. This concept seeks to put together for the combat commander and his staff a proper management setup which will facilitate timely analysis and decision. This is an Army Tactical Operations Center (Fig. 5).

The commander and his staff have available advanced summarization and display methods backed up by a computer. Communications tied in with the tactical operations center will provide the means for input and also give the commander the output means to transmit decisions and reports quickly to the proper elements of his command or to higher or adjacent headquarters.

I am sure that you realize that this brief summarization I have given illustrates only a very few examples of military systems concepts and development now under way.

"Hurry Up and Wait"

I would like to consider some common interests we have in systems planning and design, which I hope will strike a responsive chord. Foremost, I would like to point out also that we are largely coping with specific problems at operating echelons rather far down in the organizational structure. A much bigger question is how to achieve recognition of the need for extension of these techniques to top management decision-making.

For example, on the business side, industrial engineering has made big strides in the efficiency and control of factory production and direct labor costs. Contrast in the same organization the engineered and automated factory setup with the un-engineered management information system, staff organization and overhead. Similarly, top management needs in military organizations have received insufficient attention. The extensive work being done on the tactical echelons to improve decision-making and command control really has only a modest counterpart for the strategic commanders in the field and down at the Pentagon.

It seems to me also that systems development must better employ the new scientific tools offered by operations research, particularly as applied to the decision maker. Perhaps the executive must also go scientific in his viewpoint. For example, a company executive of a major firm requested and obtained—at considerable personnel, communication and computer cost—a daily sales report of all plants, divisions, and offices scattered throughout the country. The secretary accumulated them during the week and presented them to him for review each Saturday morning. The executive felt that he had more time to peruse these matters leisurely on Saturday. The old adage of "hurry up and wait" has universal application.

Another matter is the need for a sufficientlv broad multidiscipline approach in system design. Psychology, cybernetics, statistics and information theory, among others, should be employed. They can make a real contribution.

We in the Army and in the military are in the systems engineering business. We have made some steps along the road toward progress in this field. We in the Army want to be regarded as an active member in the systems community, contributing to and benefiting by mutual interests and endeavor.

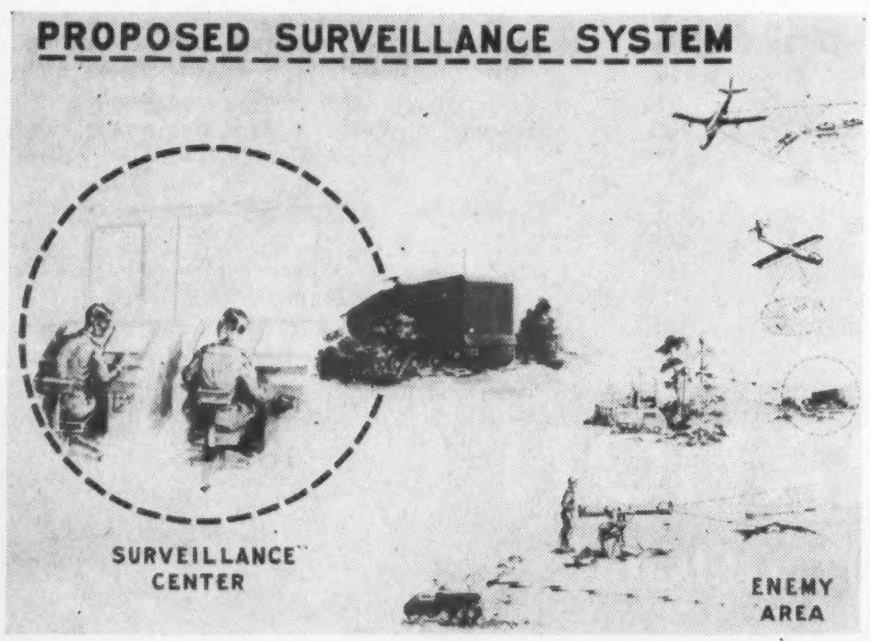


Figure 4

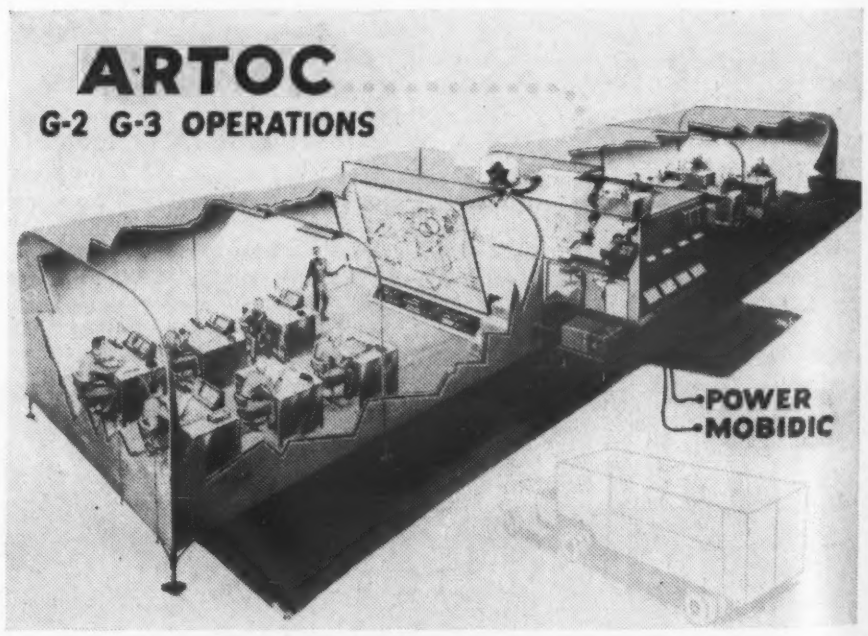


Figure 5

 (*Continued from page 39*)

RADIO CORPORATION OF AMERICA will establish a major missile and radar center at Van Nuys, Calif. with completion of the initial phase of construction due by the end of this year. Initial projects scheduled for the Van Nuys facility include work on missile check-out and launch, information handling and radar systems.

THE MINISTRY OF SUPPLY has placed a substantial contract with Marconi's Wireless Telegraph Co. for VHF Direction Finders for use at airports and airfields in the United Kingdom. The equipments, which have been ordered on behalf of the Ministry of Transport and Civil Aviation, will provide a total of 24 D.F. channels. The Direction Finders ordered are Type AD.210C, the first of a new and comprehensive series of automatic D.F. equipments, developed by Marconi's to provide in the simplest and least expensive form the direction finding requirements of an airport.

TWO MAJOR MIDWESTERN ELECTRONICS FIRMS, Amphenol Electronics Corp. and the George W. Borg Corp., have merged into Amphenol/Borg Electronics Corp. with combined assets of more than $37 million. Their headquarters will be in Chicago. Amphenol is a supplier of connectors, cables and other electronic components for missiles. Borg produces precision potentiometers, direct reading counting dials and electronic instruments.

A MERGER of Varian Associates, electronics development and manufacturing firm of Palo Alto, Calif. and Bomac Laboratories, Inc., Beverly, Mass. will combine operations through an exchange of common stock with Varian acquiring an 80% interest in Bomac and having an option to acquire the balance of the outstanding Bomac common stock. Varian is a leader in klystron tubes, while Bomac is a leader in gas-switching tubes.

GENERAL TELEPHONE CORPORATION & SYLVANIA ELECTRIC PRODUCTS INC. recently merged, following the approval of share owners of the two companies. The combined company is named General Telephone and Electronics Corp. Donald C. Power, President of General Telephone, has become Chairman of the Board and chief executive officer of the combined corporation. Don G. Mitchell, Chairman of Sylvania, has been named President of the corporation.

NORTHROP CORPORATION, Beverly Hills, Calif., is expanding into the new field of advanced systems for long-range radio communications through acquisition of Page Communications Engineers, Inc. Northrop will acquire 100% of the stock of Page and the company will be operated as a wholly-owned subsidiary of Northrop. No changes are contemplated in the executive and technical personnel of Page.

— GENERAL —

THE EIGHTH ANNUAL SINGLE SIDEBAND DINNER AND HAMFEST, sponsored by the SSB Amateur Radio Association, will be held on Tuesday, March 24, 7:30 PM at the Hotel Statler Hilton, 33rd St. and 7th Ave., N.Y.C. All amateurs and their friends are invited to attend this dinner. Bill Leonard, W2SKE, will be master of ceremonies. Tickets purchased in advance are $8.00 each and $9.00 at the door. Send reservation requests to SSBARA c/o Irv Binger, W2CMM, 1741 Andrews Ave., N. Y. 53, N. Y.

CALENDAR OF EVENTS:

MARCH 23-26: The 1959 IRE National Convention is to be held at the Waldorf Astoria and New York Coliseum in New York City. The theory and practice of Russian technology will be among the highlights of the show, and a special symposium on "Future Developments in Space," will be held on March 24.

MARCH 31-APRIL 2: Millimeter Waves will be the subject of the Ninth International Symposium of the Polytechnic Institute of Brooklyn, Microwave Research Institute, to be held in New York City. The event will be co-sponsored by Department of Defense Research Agencies and the IRE.

APRIL 6-8: The Fifth Annual National Military-Industrial Conference is to be held at Palmer House in Chicago, Ill. "The Soviet Economic Challenge" is the theme for this Conference that is sponsored by industry, government and education. Some of the principal speakers will be: Leo Cherne, Dr. Wernher von Braun, George Meaney.

APRIL 14 & 15: Application of new techniques, devices and systems to achieve better products and processes will highlight discussions at the Conference on Industrial Instrumentation and Control to be held at the Illinois Institute of Technology, Chicago, sponsored by Armour Research Foundation in cooperation with the Professional Group on Industrial Electronics of IRE.

APRIL 30-MAY 1: The first national Youth Conference on the Atom will take place at the Claridge Hotel, Atlantic City, N. J. Some 500 students and teachers from high schools will participate in this conference, which is being sponsored by approximately 60 electric utility companies. Chairman John A. McCone of the Atomic Energy Commission will address the conference on April 30.

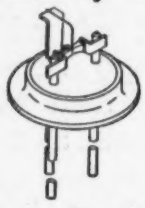
AUTOMATIC ASSEMBLY OF TRANSISTOR ACHIEVED AT WESTERN ELECTRIC

Some impressive obstacles have long blocked efforts to mechanize assembly of transistors. Among them: the tiny, closely spaced parts involved, the extreme material purity required and, especially, the constant changes in transistor design.

Yet the advantages of mechanized assembly are enticing – large volume production of a quality product at lower cost.

Recently an automatic assembly machine, at Western Electric's Allentown (Pa.) Works, began producing high quality grown junction type transistors. The only machine of its kind, it is doing what was considered – not so very long ago – practically impossible.

The grown junction transistor was chosen for automatic assembly because it promised to be fairly stable in design, making development of an assembly machine worthwhile.



Grown junction type transistor

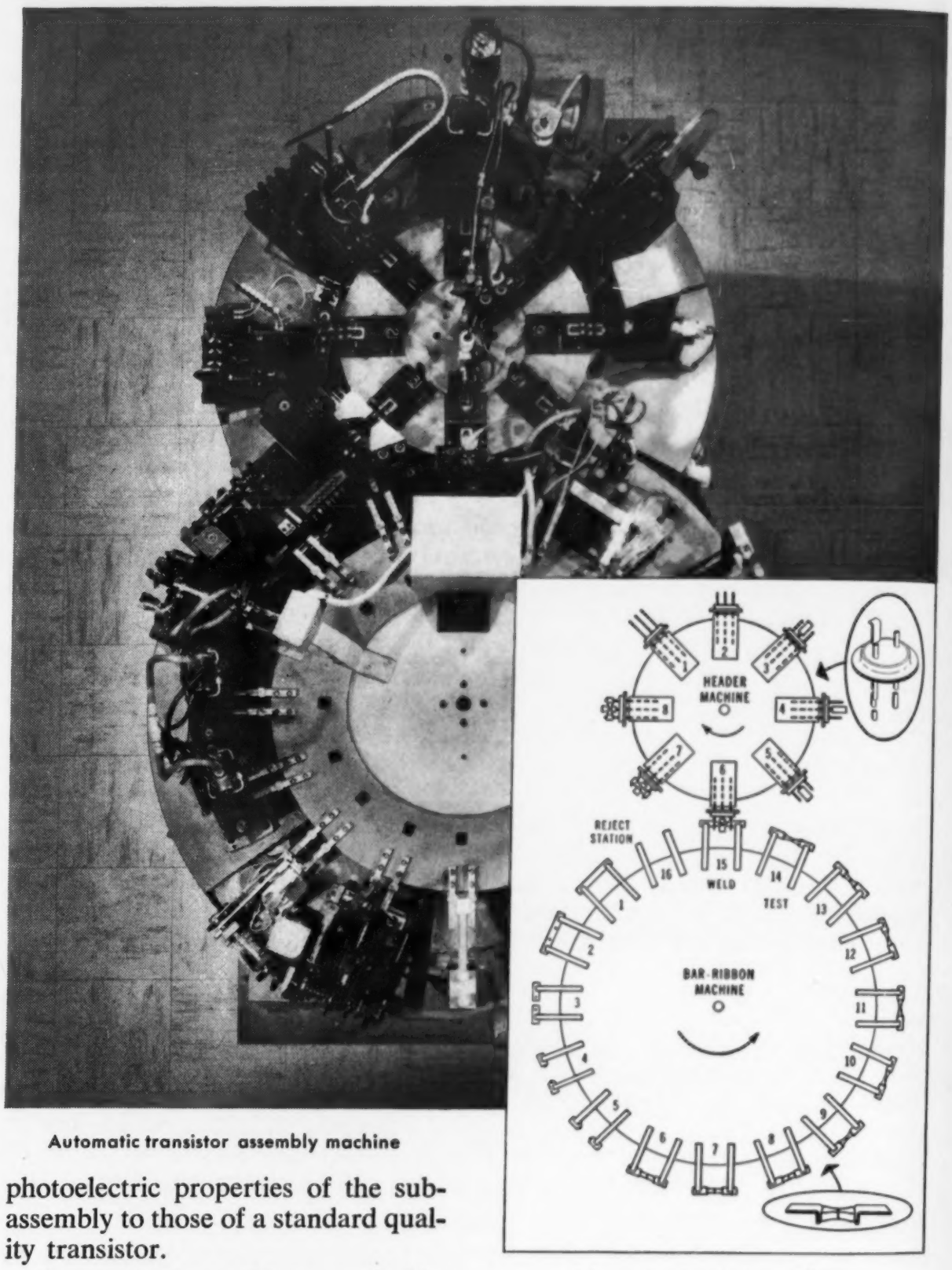
Our engineers began by collaborating with the Bell Telephone Laboratories (our Bell System teammate and inventor of the transistor) in modifying the design of this transistor, to make it more suitable for automatic assembly.

The many assembly operations could be naturally divided into two phases: processing of headers; fabrication of the bar-ribbon assembly composed of an NPN germanium bar, supported between two .005-inch thick Kovar ribbons. So a two-part machine was devised by a team of Western Electric engineers. (See schematic.)

Problems of Mechanization

Each of the individual mechanized operations making up the overall unit had to be separately designed and synchronized with the rest. Many problems came up in designing these stations.

For example, how to save expensive headers from being welded to bar-ribbon assemblies which may not meet strict Western Electric quality standards. To solve this, our engineers added a station to test each bar-ribbon assembly prior to welding it to a header. The test compares the photoelectric properties of the subassembly to those of a standard quality transistor.



Automatic transistor assembly machine

Schematic of unit shown above

When the bar-ribbon assembly passes this test, an electrical signal actuates a relay on the header machine, allowing a header to be moved to the welding position common to the two tables (station 15). If a substandard bar-ribbon is detected at the test station, the welding operation does not occur and the assembly, without header, is moved to a subsequent station (number 16) where it is ejected.

Though it is entirely possible that the grown junction type transistor – and, in part, this machine–will soon be obsolete, much has been gained. The feasibility of automatic transistor assembly has been proved, representing a long step forward in transistor manufacture and a substantial contribution to the field of automation.

This is one more example of the inventive engineering that is constantly brought to bear on Western Electric's job as manufacturing and supply unit of the Bell System.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

PART II

THE CHALLENGE OF SPACE

by
DR. GILFORD G. QUARLES
Chief Scientist, U. S. Army
Ordnance Missile Command

Synopsis

The challenges of exploration, science and benefit to the human race were the principal points of Part I of The Challenge of Space. *Dr. Quarles traced the development of science and exploration from the days of Columbus, Leonardo da Vinci and the Wright Brothers whose curiosity bade them accept the challenge of the unknown and the difficult. However, as the commercial success of these past ventures could not have foretold their potential benefits to mankind, neither can future discovery of scarce materials on the moon nor aids to navigation indicate the future potential of these explorations when man is faced with nuclear or even natural destruction.*

Possibly the greatest challenge of all in the consideration of the space age is that here at hand may be the ultimate means of eliminating the threat of war from the minds of mankind. We are presently engaged in a vast struggle of ideologies between the Communists and the democratic world. This is not a war in the conventional sense but it is a struggle for men's minds. It is a struggle between freedom and tyranny. Whereas it is possible to visualize the struggle becoming a real war and extending into outer space, it is equally possible to visualize that the exploration of space might give an increased community of interest to mankind and so bring all men to a broader and deeper mutual understanding. This might even come about through the sheer economics of space warfare. As the cost of maintaining armaments increases, we may ultimately reach the point where it is no longer economically feasible for men to disagree at the international level and, consequently, understanding and peace may be forced upon us.

This is the ultimate challenge presented to us by the age of space. As General Medaris stated in a recent speech, "the battle for the minds of men, and thus the battle between freedom and tyranny may be won in outer space, the greatest challenge of all time." This does not mean that space armies will battle to the end on the moon or Mars or outer space. Rather, it is suggested that the equipment of peace and the incentive for peace may well be found in the exploration of space, which was begun with the launching of the Russian Sputnik over a year ago (October 4, 1957).

But what about the challenge to be met by the individual citizen with a primary interest in the fields of packaging and handling. What are some of the challenges that are presented to him by this over-all challenge of the exploration of space? Some of the areas in which such challenges may be sought are:

First, there is the major problem of propulsion. Although our chemical rocket fuels have been developed amazingly in the past few years, they leave much to be desired. The specific impulse that is achievable with existing or contemplated chemical fuels would not enable us to travel far beyond Mars. Other methods of propulsion and on which some research has already been done include the use of nuclear power instead of chemical reaction for providing heat, and the use of ions or ionic plasma accelerated by electric and magnetic fields. Still a fourth method of propulsion that has been proposed and on which some analytical work has been done is that of the use of photons or light energy as the actual propellant. These photons would be derived from the direct conversion of matter into radiant energy. This method would provide the most efficient utilization presently conceivable for available energy. Utilizing such a system to travel from earth to Mars, a 600-ton pay load would require only about six thousand pounds of fuel. To travel to the nearest star would require about 1200 tons of fuel. But for some space trips, the amount of fuel would be fantastic. For example, to make a round trip through the universe would require 600×10^{19} tons of fuel, which happens to be just the mass of the entire earth. It is apparent then that the possibility of travel through the entire universe presents some challenges other than that of time, as discussed earlier. A second area of engineering challenge is that of materials. Not only will we need new materials to withstand environmental conditions encountered in space ships—the high temperatures encountered in the propulsion systems, the wearing effects of meteors and meteorites, the temperatures encountered in the extremes of outer space—but we also require materials that have a maximum of strength and a minimum of weight. The cost per pound is a basic figure of merit for space transportation, since once the vehicle gets beyond the gravitational effects of the earth, the cost per mile is insignificant. On the basis of present costs, it is estimated that for a ship to travel to the moon, to land, and return to the earth utilizing present technology, each pound of weight unnecessarily left in the pay load package would cost approximately $100,000. The challenge to reduce the weight and to increase the strength of the structural materials used in such a payload is immediately apparent from the monetary view point.

The problems of establishing a space station beyond the atmosphere of the earth and the problem of keeping it supplied present some major logistic and handling problems. Navigation to such a station and from a station to the moon or to Mars and through outer space, also presents a definite challenge to the engineer and the designer.

Since there will be no source of food or air in outer space, it will be necessary to package either an adequate supply or the the necessary equipment for regenerating these essential life elements on a closed-cycle basis. This, in itself, possibly presents the greatest challenge to the packaging industry of the whole field of space exploration.

Still another packaging challenge stems from the necessity for getting man from outer space back to the earth. It is possible with existing technology to get a man from the earth into outer space; however, the problems of reentry for a man-carrying vehicle have not yet been solved. It is well-known, I believe, that the problem of heat dissipation for a long-range missile warhead reentering the atmosphere has been solved. Unfortunately, although this solves the problem of heat dissipation, it does not solve the problem of extreme accelerations which must be eliminated before man can adequately re-enter the atmosphere.

Still another aspect of the challenge from the packaging point of view is in

(*Continued on page* 92)

Cold Cathode Tube

(*Continued from page* 50)

During the year 1958 nearly 500 million or ½ billion small vacuum tubes were manufactured. Each of these contains a source of electrons called the cathode that must be red hot in order to operate. Every tube in your radio and in your television set has one of these red hot cathodes. It consists of a small hollow cylinder of nickel on the outer surface of which there is a coating of Barium and Strontium oxides. Inside the cylinder is a heater made up of a glowing tungsten filament which heats the whole cathode to a red heat. Electrons are literally boiled off the oxide surface by the heat just as steam is released from boiling water. This type of cathode has been used for about 40 years in receiving tubes.

Up to now, there has never been any other type of cathode that could be used in these tubes. The significance of this new cold cathode is that it can be made to do the same job and serve the same function as the corresponding hot cathode tubes.

Magnesium oxide which is used in the tube is a phosphor, that is, it emits light when bombarded by electrons. As the electrons strike the atoms of magnesium oxide in their outward passage through the layers, they cause the emission of light and this we believe is the source of the cold blue luminescence that is the pecular identifying mark of the cold cathode.

When voltage is first applied to a tube containing this cathode the surface is not positively charged, and emission does not take place. It is necessary by some means to charge the surface to this operating voltage and we have developed several methods that will do this in a fraction of a second to start the emission.

In application how does it compare with the hot cathode? There are obvious advantages over the hot cathode but there are also some disadvantages. The advantages are: less cathode power required for operation, quick starting, much longer life and no trouble from faulty heater operation.

There are these disadvantages. Even though the over-all power is substantially less, a minimum voltage of about 300 volts is necessary for operation. The present tubes are not self starting; a starting means must be provided. The tubes are slightly more complex internally. The two types are about equal with respect to cost, noise level, and some other characteristics.

Preparing the Cathode Coating

The work at Tung-Sol started on July 1, 1956 when the original Signal Corps contract became effective. Of the various methods of preparing the cathode coating that had been explored at the Signal Corps we chose the spray technique and concentrated all effort on it. This is the same technique that is used for the hot cathode. The magnesium oxide is a white powdery substance that is familiar to you as the main ingredient in milk of magnesia, procurable in any drug store. Actually, we have made cathodes with milk of magnesia because of its excellent purity and they have worked quite well. However, as the work has progressed we found other sources of pure magnesium oxide and by mixing in other magnesium compounds which break down to give pure oxide and to make the coating porous, the present process has been developed.

This was the first real advance in the development. Its result was a commercially acceptable product, reproducible, reliable and stable in operation. The processing is so similar to that of the hot cathode that the same factory machines may be used.

During the operation of the hot cathode the active ingredients are continually evaporated off and when they are gone the end of life point is reached. However, during the operation of the cold cathode, there is no apparent depletion of elements. Thus, very long life may be expected. One of the early tubes has been in continuous operation for 14,000 hours without any decrease in the emission.

The early designs produced in the laboratory did not lend themselves to incorporation in present vacuum tube structures. The next significant advance was the adaptation of this cathode and its processing to receiving tube structures so that standard receiving tube parts could be used. The cold cathode tubes then began to look like typical hot cathode tubes.

We next developed several simple and practical means for starting the emission. One of these can be made automatic so as to function whenever the tube is turned on without any added effort on the part of the operator.

There remained to be carried out an investigation of the exact characteristics of the electron emission itself and as soon as this was completed we were able to design and produce practical tubes.

The first such tube developed was an audio output amplifier. It puts out enough power to drive a hi-fidelity loud speaker. Outwardly it looks exactly like a hot cathode tube since it is made of similar parts.

The development work now is concentrated on other types of tubes. One of these is a preamplifier employing secondary emission that will produce more amplification than any commercial hot cathode tube. Sample tubes of this kind have already been produced successfully. Other types will follow so that complete electronic devices can be made employing cold cathode tubes throughout.

Many Future Possibilities

One objective of this program is a radio that will play as soon as it is turned on and one in which the tubes should outlast the radio itself.

Another development presently underway is a cold cathode electron gun for use in cathode ray tubes for television, and in klystrons, travelling wave tubes and the like.

In the design stage is a flat, picture-on-the-wall display device for television or radar. It appears to be possible to produce brightness in such a device greater than that of any present picture tube.

Tung-Sol factories turn out millions of lamps most of them miniature or sealed beam types. We are, therefore, interested in any new type of lamp. Based on our present knowledge and experience with the cold cathode, we know that we can produce a lamp for general illumination purposes that would have all of the outward appearances of the present fluorescent lamp that is widely used in homes and factories. It should have greater brightness, the same color of light, and much longer life. In one regard it would be greatly superior, for it would shine just as brightly at 50° below zero in the arctic regions as it would in the 100° temperatures at the equator. No commercial fluorescent lamp will operate satisfactorily over such a temperature range.

The economics of this lamp will be the determining factor in its use in the lighting industry.

There are a host of other applications where the particular advantages appear to fit a need.

- In garage door openers where instant starting is particularly desirable.
- In electronic computers where the elimination of the heater would pay dividends in reliability and in total power drain.
- In many industrial and automation control circuits for the same reasons.
- In telephone cables buried at the bottom of the sea where the unlimited life would be advantageous and in earth satellites where the low power drain would make operation on solar batteries feasible and where the long life and resistance to radiation from outer space would provide reliable functioning for years of orbiting.

After 10 years of intensive effort it has become increasingly evident that the transistor is not the answer to all electronic problems. We see in this new cold cathode development a broad field of usefulness in these areas where both hot cathode tubes and transistors have proved inadequate.

ATLAS, front-ranking ICBM and satellite vehicle, is shown at the tense moment as it "lifts off" for another history-making flight. This Convair missile uses precision components made by Texas Instruments.

(Air Force photo)

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photoprogress

by FRANK SMITH
SIGNAL PHOTO EDITOR

New Avco Rotating Mirror and Rotating Drum Cameras

Two laboratory standard instruments—rotating mirror and rotating drum cameras—to provide accurate and reliable photographic records of hypervelocity phenomena have been developed for sale by Avco Manufacturing Corporation's Research and Advanced Development Div., Wilmington, Mass.

The devices are valuable in studies of radiation, explosive compound development, solid fuel ignition, propulsion, ballistics combustion, chemical recombination, plasma tunnels, magneto-hydrodynamics, spark gap discharges, high speed electromechanical units such as relays and other transient events which emit or reflect light.

The rotating mirror camera records position-versus-time relationships, sweeping the image from a hypersonic object source onto fast emulsion film strips. Heart of the unit is a hexagonal, first surface mirror, rotating at 3000 rps, which provides writing speed of 4 mm/microsecond for total writing time of 50 microseconds. Other components are a cast aluminum main housing, standard f/2.5 lens, two curved film holders and air turbine drive.

The rotating drum camera, in addition to making position-time film records, also may be used with a densitometer to produce accurate data of hypervelocity phenomena. A precision-manufactured, dynamically-balanced drum, rotating at 600 rps for writing speed of 0.19 mm/microsecond and total writing time of 1667 microseconds, distinguishes this second instrument. The fast emulsion film is fixed to the inner periphery of the drum.

Both cameras operate on compressed air, driven through shaped nozzles at turbines integral with either the rotating mirror or drum units.

Sampson-Hall Professional Underwater Motion Picture Camera Housing

For those whose motion picture work calls for underwater camera housings of professional quality, Sampson-Hall Co., 7268 Franklin Ave., Hollywood 46, Calif. has developed a standard 16 model professional underwater camera housing which accommodates the Bell and Howell 16mm 70-DL, 70-DA and also the old Model 70 when converted. The standard housing is calibrated for Elgeet 13mm wide angle f/1.5 lens.

The camera and housing out of water weighs approximately 25 lbs., however, underwater it weighs but a few ounces. The Sampson 16mm standard professional underwater camera housing without camera or accessories is priced at $370.00 and is distributed by Gordon Enterprises, 5362 N. Cahuenga Blvd., N. Hollywood, Calif.

Aerial Spotting Camera Uses Polaroid Film

The Mast Development Co., Inc., Model 110, 10″ focal length spotting camera was developed for aerial reconnaissance photography. It has both civilian and military telephoto applications where instant photographs are needed. This hand-held long-range camera uses 8-exposure Polaroid roll film and, in a standard Polaroid camera back, provides 60 second-in-camera development of exposures. Each 3″ x 4″ positive opaque photograph can be checked before leaving the location.

Over-all dimensions of the Model 110 are 5⅜″ high, 9⅝″ wide, and 11″ long.

Additional information may be obtained from the company, 2212 E. 12th St., Davenport, Iowa.

New Beckman and Whitley, Inc. High-Speed Cameras

Two new high-speed cameras have been announced by Beckman and Whitley, Inc., San Carlos, Calif.

The new cameras, designated as the Dynafax High-Speed Motion-Analysis Camera and the Model 194 Continuous-Writing Streak Camera, add new tools to the photographic instrumentation field.

The first of these—the Dynafax provides high-speed motion analysis photographs at an upper rate of 25,000 16-mm frames per second, and extends the range of previously recordable subject matter.

The Dynafax camera is 12 inches in diameter by 10 inches long over-all and weighs 28 lbs. It is arranged for operation on any tripod having a standard mount.

The other camera, the new model 194 continuous-writing streak camera, is a research tool for the photo-instrumentation study of self-luminous transient events and produces a documentation which is a plot of space in one direction versus time in a 90 degree direction.

Primary applications will be in the study of explosions, shock-tube manifestations, and flash-tube and spark discharge phenomena. Because of the continuous-writing feature, the requirement of synchronizing the camera and the event is eliminated, greatly simplifying use.

New "Picture-in-a-Minute" Products from Polaroid

New Polaroid Land Camera, Model 110A (The Pathfinder). A new version of the Polaroid "Pathfinder" Land Camera, leading model in the line of 60-second cameras, has been announced by Polaroid Corp., Cambridge 39, Mass.

Known as Model 110A, the latest Polaroid Land Camera offers a wide range of lens openings and shutter speeds as the earlier version (Model 110) but, in addition, features a completely redesigned coupled rangefinder and new automatic parallax-correcting viewfinder.

The new "Pathfinder" is considerably lower in price than its predecessor, retailing for $169.50 compared to the former price of $249.50. It produces a 3¼″ x 4¼″ print one minute after the picture is snapped.

New Polaroid Land 4 x 5 Film Holder

A new Polaroid Land 4 x 5 Film Holder which instantly adapts your 4 x 5 camera for 60-second pictures, has also been announced.

This new film holder is interchangeable with regular film holders. Merely slide it in and you are ready to produce a finished full-size 4 x 5 picture of professional quality in 60 seconds. There is no change in film plane, no adjustment of rangefinder or ground glass. The holder remains in the cameras as you shoot picture after picture without delay. A new specially designed 4 x 5 film packet contains negative, positive sheet and developing pod—all the elements necessary for making 60-second pictures.

Polaroid's New 4 x 5 Sheet Films

Perhaps the most exciting news emanating lately from Polaroid is the announcement concerning their new 4 x 5 sheet films.

These new sheet films are for use in the holder described above and, in principle, the films are similar to previous Polaroid products. However, instead of being in rolls, a single negative, its positive print sheet, and a pod of developer have been ingeniously combined in a light-tight paper envelope. The unit is called a film packet.

(*Continued on page 66*)

TOP HAT

TUBE CLAMPS

RETAINERS FOR PLUG-IN COMPONENTS

An improved clamp for securing electron tubes, relays, capacitors and other pluggable parts.

POSITIVE Component even when inverted will not loosen under the most severe shock or vibration.

CORROSION RESISTANT Hats and Posts are stainless steel. All materials and finishes comply with Armed Forces Specifications.

RESILIENT Positive retention is achieved with minimum rigidity or strain on component.

ACCESSIBLE Clamp fits on top of component and can be fastened or released easily without tools.

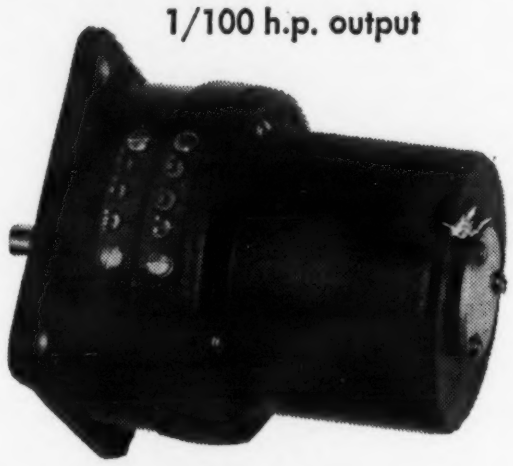
TIMES FACSIMILE CORPORATION

540 West 58th Street, New York 19, N. Y.—1523 L Street N. W., Washington 5, D. C.

MODEL GS SYNCHRONOUS MOTOR

WITH INTEGRAL START MOTOR — CONSTANT ANGULAR ROTATION ± 0.1 DEGREES — NO LOAD TO FULL LOAD!

1/100 h.p. output



A phonic wheel type motor capable of operating from vacuum tube amplifiers on signal frequencies from 60 to 3600 cps. It was designed to provide the extremely accurate and invariable speed required for driving fork-synchronized facsimile equipment. Its unique characteristics will be found the answer to many problems involving the need for constant angular rotation or precise synchronization.

The Model GS Motor can be operated single phase in the plate circuit of a single-ended amplifier or as a two phase motor when driven by a push-pull amplifier. The latter is recommended since the two-phase connection runs quieter and provides more power with less heating. The motor current is about 75 milliamperes per phase. The power input may be as high as 20 watts.

TIMES FACSIMILE CORPORATION

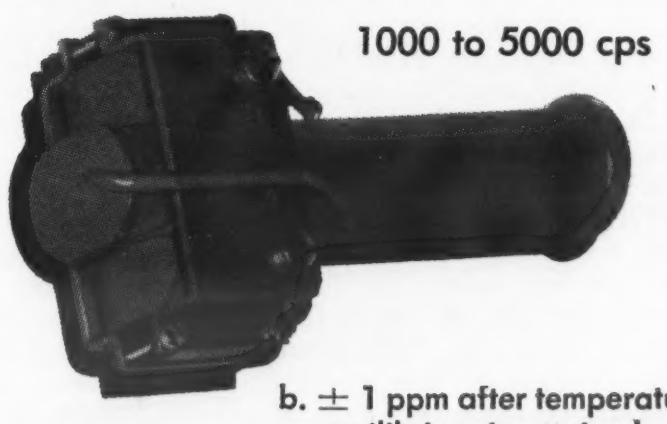
540 West 58th Street, New York 19, N. Y.—1523 L Street N. W., Washington 5, D. C.

Accurate Audio Frequency 1 part in 10^7

FORK OSCILLATORS

for the most precise timing and frequency control — new fork unit designed for high environmental vibration uses

1000 to 5000 cps



FEATURES

In Audio Frequency systems, the fork has advantages over other types of oscillators including crystals

- **INTRINSIC STABILITY — Superior at Audio Frequencies**
- **TEMPERATURE COMPENSATED**
- **RUGGED MECHANICAL DESIGN**
- **STABILITY NOT DEPENDENT ON AMPLIFIER COMPONENTS (in recommended circuits)**
- **STABLE OPERATION WITHIN 5 MINUTES**
- **LOW AGING RATE**

SPECIFICATIONS

frequency stability

a. ± 3 ppm room ambient (no oven)

b. ± 1 ppm after temperature equilibrium is attained ± 5°C

c. Long term drift less than 5 ppm per annum after first 3 months

TIMES FACSIMILE CORPORATION

540 West 58th Street, New York 19, N. Y.—1523 L Street N. W., Washington 5, D. C.

Bell and Howell New Automated Still Picture Camera

A new, completely automatic still picture camera has been developed by the Bell and Howell Company, 7100 McCormick Road, Chicago 45, Illinois, originator of the electric eye concept for movie cameras.

The new camera, called the Infallible, is now available from photo dealers in limited supply. The retail price of $19.95 includes a flash gun for indoor photography and a leather carrying case. It uses the popular 127 size film in black and white or color.

Unlike a number of still cameras which incorporate light meters but require manual exposure setting or focusing, the Infallible is fully automatic. Photocell, or electric eye, not only computes the light reading, but also sets the lens opening, leaving the photographer free to sight and shoot. The lens requires no focusing.

Dimensions of the camera are 3¾ inches wide, 2⅞ inches deep, and 4⅝ inches high and it weighs 24 ounces.

The flash gun is battery capacitor operated for use with GE M-5 and Sylvania M-25 flashlamps. It uses a 15 V, 504 Eveready photoflash B-C battery.

High-Speed Framing Disk Camera

C. H. Bagley of the Poulter Laboratories, Stanford Research Institute, Menlo Park, Calif., writing in the *Review of Scientific Instruments* for Oct. 1958, describes and discusses a high-speed framing camera designed to investigate problems requiring a time coverage of from 6 to 20 milliseconds which has been developed.

A unique feature of the camera is that it combines the short exposure times of the rotating mirror framing cameras with a rotating disk which is used as a film transport. The author claims that 60 pictures at framing rates up to 15,000 frames per second are possible.

Machine for Photographing, Processing and Projecting a Picture in 0.2 Second

One of the prime objectives in military photography is the fast development of pictures which may be viewed or projected immediately or nearly so, after taking.

To meet this need, there has been developed at the U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J. a combined picture taking, processing and projection machine which does all these operations in the very short time of 0.2 second.

The machine is an invention of Carl Orlando of the Laboratory staff and was designed for obtaining pertinent information from a cathode-ray tube presentation. Orlando's invention differs somewhat from machines of this type in that it is designed to use two-solution processing which is claimed to give results superior to those obtained with monobath processing.

Essentially, Orlando's system consists of an apparatus for rapid photographic reproduction and projection comprising a taking lens, sensitive film, a light-tight housing for protecting the film until development is completed, means to hold the film at the focal plane of the lens, means operable at the focal plane for developing the film, a fixing chamber closely adjacent to the developing means, the fixing chamber being transparent and containing a fixing solution, a projection lens, means to hold the film in the focal plane of the projection lens within the fixing chamber, means to transport the exposed film from its taking and developing position and a projecting light source directing its beam through the fixing chamber, film and lens.

Orlando was granted U. S. Patent No. 2,856,829 Oct. 21, 1958 for his invention.

A detailed description and discussion of the machine is contained in an illustrated paper by Mr. Orlando published in *Photographic Science and Engineering*, Oct. 1958.

G.E. Golden Crown Exposure Meter

A new high sensitive, photoelectric exposure meter, the Golden Crown (Type PR-3), has been announced by General Electric Co., Instrument Dept., West Lynn, Mass.

Easy to use, the Golden Crown gives exact lens settings for perfectly exposed pictures—in just five seconds, reading either reflected or incident light. A pointer lock button holds the reading. When used with a Dynacel light multiplier attachment, the meter provides four times greater reflected light sensitivity than any previous GE exposure meter and takes the guesswork out of available light photography.

Price for the Golden Crown with its eveready leather case is $34.50. The Dynacel is priced at $7.50 and the incident light attachment at $1.50.

Exposure values, f/stops, or Polaroid Land numbers are read directly on the meter. The user may pre-set the shutter speed and the pointer will then indicate the correct lens opening directly on the outer dial.

Exposure data, computed by the meter, cover a wide range —all present ASA film speeds and equivalent film speeds up to 20,000: shutter speeds from 120 second to 1/32,000 second, and f/stops from f/1 to f/45.

Flash! World's Smallest Flashbulb by G.E.

Good news for flashbulb users is contained in an announcement by General Electric Co., Photo Lamp Dept., Nela Park, Cleveland 12, Ohio, of the development and availability of what is claimed to be the world's smallest photo flashbulb.

Called the "All-Glass" flashbulb, it has a grooved glass base designed especially for use in multi-lamp clips much like clips used in automatic pistols.

Not much larger than a jelly bean, 1⅛" long, the tiny all-glass flashbulb will:

1. Make possible rapid-fire flash cameras which will fit—flashholder, lamps and all—in the palm of your hand.
2. Provide, at least cost, as much light output as lamps four times its size.

Although only one quarter the size of present M2 flashbulbs, the zirconium-filled lamp in its small reflector delivers the same light output, 7000 lumen seconds and 4000 in the blue version.

GE engineers envision a flash-holder with a multi-lamp clip stored in its handle. Lamps would be advanced like film by means of a lever. After one lamp is fired, insertion of the second lamp would eject the first and reload.

The lamp will be available in April 1959 with a suggested retail price of 10¢ each. A blue version will be 12¢ each.

World's Smallest Movie Camera

What is claimed to be the world's smallest movie camera, the new Bolsey 8, has been announced by its manufacturer, Bolsey-Delmonico, 42-24 Orchard St., Long Island City, New York.

The Bolsey 8 measures only 3⅛" x 1⅛" and weighs only 12 ounces when fully loaded with 25 feet of single 8mm film in magazine.

One full winding of the key provides from 8 to 10 feet of shooting at a standard 16 frames per second for normal movie-taking, or single frame exposures for still picture taking simply by rotating the exposure button from "M" to "S."

An exclusive feature of the Bolsey 8 is a variable shutter. Shutter speeds are variable allowing exposure time of 1/50, 1/200, 1/300 or 1/600 of a second.

The Bolsey 8 features an f/1.8 w/f = 10mm Bolsey-Elgeet lens with stops from f/1.8 to f/22 and focuses from 1 foot to infinity, but, due to its tremendous depth of field, it can easily be handled as a fixed "universal" focus camera.

The optical viewfinder is extremely clear and provides for comfortable viewing even with eye glasses. A slip-on 20mm f/2.2 telephoto lens and a 6½mm f/2.2 wide angle lens are also available.

The camera uses a new type of magazine containing 25-feet of Kodachrome single 8mm film. This magazine is of a new and radical, yet simple design. The single 8 film is just half the width of the standard double 8 film which ordinarily is split after processing.

The camera is priced at $99.50 and includes chrome wrist chain, two film magazines (loaded), including processing and return. Other accessories (besides lenses) include a soft leather pouch, leather carrying case, tripod adapter and filters.

Armed Forces Communications and Electronics Association

AFCEA

Ten Reasons For Joining

- Membership in a national non-profit, non-sectarian, non-political association, whose aims are entirely patriotic and whose interests are in the communications-electronics-photography field.

- An opportunity to take an active part in preparing for the defense of the United States in time of national emergency.

- A chance to help stimulate and keep alive interest in a most vital phase of our national security . . . industrial preparedness. See page 70 for a list of AFCEA's group members.

- Participation in the professional, technical and social activities of the national association and its local chapters.

- As an AFCEA chapter member, to meet and know leaders—from both Industry and Armed Services—in our communications-electronics-photography field. See page 72 for the list of AFCEA Chapters throughout the world.

- Being a definite part of the civilian-military team, with the opportunity of meeting with fellow teammates in good fellowship and friendship.

- A subscription to SIGNAL, journal of the Association, which is the outstanding magazine in the combined fields of communications, electronics and photography.

- An opportunity to interchange ideas through articles and letters on a national and international basis.

- A Service Department which, upon order, supplies members with books, membership certificates, AFCEA insignia, etc.

- A National Headquarters in Washington, D. C., which may be called upon for advice and assistance, by both individual and group members.

Membership application on page 92

Visit the AFCEA-SIGNAL Exhibit at the IRE Show, NYC, March 23-26 • Booth 1100

Extra copies of this special issue on Components may be ordered by writing to the Editor. $1.00 each, 10 or more: 75¢ each. ⟶

Colonel W. J. Baird, Editor
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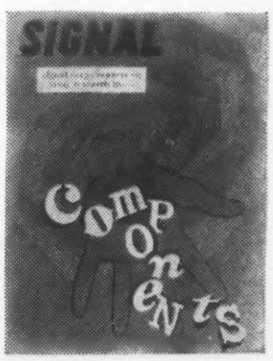

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**Executive Committee Member.*

Association affairs

Stone and Ankenbrandt Direct Air Force Communications Program

Rear Admiral Ellery W. Stone, U.S.N.R. (Ret.), and Maj. Gen. F. L. Ankenbrandt, USAF (Ret.), both AFCEA National Directors, have been named director and deputy director, respectively, of a program to expand the Air Force world-wide communications network.

International Telephone & Telegraph Corporation and Radio Corporation of America have been awarded a contract from the Air Force for the development, design and master planning of the communications support system. Admiral Stone is Chairman of the Board of American Cable & Radio Corp., an ITT subsidiary. General Ankenbrandt is manager of RCA Defense Projects.

The system, designated 480-L, will provide improvement and modernization of AIRCOM, the Air Force's world-wide, point-to-point and air-to-ground communications system. The aim of the program will be to develop a communications system capable of meeting foreseen and anticipated requirements of the Air Force, including great increases in needs for data processing and voice communications. The program is intended to fulfill Air Force requirements from the present to 1970 and beyond.

The ITT-RCA team was chosen by a Source Selection Board, consisting of representatives of the Air Research & Development Command, the Air Materiel Command, Airways & Air Communications Service and USAF Headquarters.

Amateur Station for CCIR Session

Radio amateurs of Southern California and Arizona, under the direction of Ray Meyers (W6MLZ), South West Director, American Radio Relay League (ARRL), will install and operate a completely equipped amateur radio station at the Biltmore Hotel, Los Angeles, Calif., for the Ninth Plenary Session of the Consultative Committee International Radio (CCIR).

The Federal Communications Commission and the State Department have assigned and approved the special call letters K6USA for this conference, which will start April 1 and last approximately six weeks.

Ham Directory

The AFCEA ham operators directory is now off the press. Divided into two parts, this 20-page booklet lists first the frequencies and geographic locations where operators can be found. The second part presents a listing of the operators, their addresses and their job positions. The directory measures 7½" by 5½".

Compiled by Ray Meyers, Region F Vice President, the directory was printed by Price Swinney, President, Tri-Ex Tower Corporation of Los Angeles and Tulare, California.

Copies of the directory have been sent to each Chapter Secretary in order that local chapter members may be kept posted on ham activities.

AFCEA's New Group Members

Andrew Corporation

Andrew Corporation, 363 East 75th Street, Chicago 19, Illinois, has recently returned to the group membership of AFCEA. This firm is concerned with antennas, antenna systems and transmission lines.

The company representatives in AFCEA will be: Robert P. Lamons, Director of Marketing; Robert C. Bickel, Marketing Manager; C. Robert Lane, Eastern Regional Mgr.; Henry F. Miller, Sales Engineer Manager; Harold J. Detlefs, Lawrence R. Krahe, Douglas E. Proctor, Edward J. Dwyer and J. Rilee Lindquist, Sales Engineers and Jeff D. Montgomery, Jr., Manager.

General Analysis Corporation

The newest group member of AFCEA is the General Analysis Corporation, P. O. Box 766, Fort Huachuca, Arizona, a firm doing operations research for Government and business at Fort Huachuca.

Members of the firm who will be the company representatives in AFCEA are: Alexander M. Mood, President; George W. Brown, Vice President; Irvin R. Whiteman, Lester R. Ford, Paul N. Somerville, Helmut Ternow, Frank C. Pethel, Reginald P. Lyman, Robert C. Danser and Lloyd Snapp, Project Directors.

As we go to press, SIGNAL has received news that the Beiser Aviation Corp., Fort Huachuca, Arizona, and Litton Industries, Inc., Beverly Hills, Calif., have become AFCEA group members. Information about these companies will be published in the April issue.

NEW MEMBERS

Listed below are new members of the AFCEA who have joined the Association during the month of January. Members are listed under the Chapter with which they are affiliated. The February listing will appear in the April issue.

ARIZONA
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Lester R. Ford
Paul N. Somerville
Helmut Ternow
Frank C. Pethel
Reginald P. Lyman
Robert C. Danser
Lloyd Snapp

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L. A. Wood, Jr.
Lewis W. Campbell, Jr.
J. M. Parker
William F. Rice
Clyde Harrelson
Arthur M. Bennett, Jr.
Harry E. Snipes
Searcy D. McClure, Jr.
Charles L. Crawley
Walter L. Saye
Charles M. Armstrong
Charles E. Martin

AUGUSTA-FORT GORDON
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1st Lt. George A. Hermes
L. C. Phillips

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Capt. Theodore A. Torgerson
LCdr. Alexander J. Michaels

BOSTON
Marcus G. Steele
C. W. Halligan
Charles A. Gorman, Jr.
LCdr. Daniel A. Sullivan

CHICAGO
Alec Kinsfather
Lt. Col. Dwight W. Langham
Daniel L. Anderson
Lloyd R. Scott
Wendell E. Matchett
Cdr. William F. Harvey, Jr.
W. Heeman
Everett K. Knox
William F. Boyd

DAYTON-WRIGHT
Jesse L. Nickels

DECATUR
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Arvid C. Engdale
Charles E. Rothwell, Jr.
Larry L. Reich
David E. Sowa
Morris L. Shaver
Charles E. Rothwell
Rudolph L. Niemeyer
R. Richard Murphy
Walter L. Morganthaler
Donald W. Mahoney
John L. Lorton
William J. Harland
Ralph G. Johnson
Elmer H. Gehlbach, Jr.
Dale E. Greenwood
T-Sgt. John Fields
Robert L. Ellis
Dwight E. Cripe
Lowell G. Burry
James D. Balderson
Roy E. Atteberry
Harold D. White
James R. Wabel
John F. Stull
Jim M. Roarick
Raymond H. Kramer
George W. Steffen
John M. Whalen
Floyd H. Scranton
Ross K. Novotny
Stanley D. Honn
George Good
MSgt John E. Goddard
Coney E. Getz
Ben H. Dunbar
Carl Craft
Billy L. Brown
Harry F. Armstrong
Andrew S. Chan
Glenn L. Clark
Jackie E. Powell
Glenn E. Rauh
Pfc Robert D. Varvel
Eddie Williams

FORT MONMOUTH
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Roderick C. Davis
Pvt. Leslie N. Coolbaugh
Donald D. Halstead
E-2 John A. Evelyn
James M. Erhardt
Pvt. E-1 James G. Bass
Albert Laxx
Robert M. Cowgill
Lt. Col. Benjamin Bell
Col. Robert F. Wilson
Thomas H. King
Robert H. Sugarman
Harold B. Churchill
Capt. Peter A. Madden
T. J. Cowgill
Sp-4 Richard D. Philpott
Pvt E-2 John Groves
Louis Mayersohn
Charles De Leonard
2nd Lt. Joseph C. Pisaniello
Jack M. Carpman
2nd Lt. Alexander Vranos
Margaretta V. H. Stone
John A. Zemalkowski
2nd Lt. Philip M. Tischler
1st Lt. George T. Washington
Lt. Col. Walter White, Jr.
William B. Lackey
John Estok
Frank J. Kane
Rita B. Gaber
Edward M. McGovern
Hans J. aufm Kampe
Morton L. Baron
Joseph P. Vang
Capt. Greg G. Lentzakis
Lester J. Bogart
James L. Malony
Maj. Joseph F. Struneski
CWO-2 Howard F. Patchett
Hugh J. Byrnes
Bayard R. Corson
Lt. Col. Richard K. De Sante
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Lawrence A. Romard

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Arthur L. Bunnell
MSgt. Joseph E. Broussard
Maj. Leonard V. Luke
Waitsell L. Givens
William S. Miller
George T. Chinen
Dick T. Kimura, Sr.
Louis L. George, Jr.
Capt. Jack Mann
Harry H. Onaka
Capt. Dale R. Bushey
Herbert M. Costello
Edward L. Dorman

KANSAS CITY
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KOREAN
Maj. Paul G. Francis

LEXINGTON
A. Scott Rossi

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Richard J. Yates

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William A. St. John

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George W. Hails
Robert E. Paravicini
Maj. George W. Mosall
Lt. Col. George L. Madara

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Joseph G. Kohlweiss
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1st Lt. Frank Zeller
Peter M. Matuk
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Floyd H. Bay
William J. Walsh

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Richard D. Anderson
Thomas L. Hayden
Waldron P. Hodsdon
Sherwin R. Rausch
Stephen M. Smith
Norman E. Tibbetts

NORTHWEST FLORIDA
Donald F. Maguire

ORANGE
James L. Layne
William M. Jamieson

PARIS
Col. Raffaele Barbieri
Elwood R. Horwinski

PHILADELPHIA
Kenneth C. Schaefer
L. M. Davis
Capt. F. S. Stich
Frank Prina
Jay Spolan
L. R. Grauel
Francis S. Gambone

ROCKY MOUNTAIN
James H. Knott, Jr.

ROME-UTICA
William H. Striegel

SAN JUAN
Robert A. Pinder
Edward A. Kildare

SAN FRANCISCO
Capt. Harold C. Hohbach
Dr. Rudolph G. E. Hutter
LCdr. Hubert A. Shores
Jesse R. Lien

SCOTT-ST. LOUIS
Wallace W. Warner
Arthur B. Jarvis

SEATTLE
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Edgar J. Stuver
Robert J. Madden, Jr.

SOUTH CAROLINA
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William W. Gunter
Samuel A. Hunt, Jr.
John J. Myers
James E. Land
Robert M. Lowery
Clarence E. Edwards, Jr.
A-1c Farrell T. Woods
Donald D. Harris

SOUTH TEXAS
James E. Crain, Jr.

SOUTHERN CALIFORNIA
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Ralph J. Swonk
Harry K. Brown
James Schaeffer
John Koys
Philip C. Orth
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John E. Wells
RAdm. James S. Laidlaw
Alexander M. Mood
George W. Brown
Irvin R. Whiteman
John A. Wells
W. F. Sampson
F. D. Calkins
R. Conner

TINKER-OKLAHOMA CITY
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Russell K. Morgan
Albert I. Rauscher

TOKYO
James Y. S. Lee
Richard C. Clayton
B. Clay Willmarth
Clifford O. Tillis
William R. Freeman
Albert F. Everett
Frank F. Lesage
Toshio Shimizu
Thomas T. Kato
Ralph M. Saito

WASHINGTON
Russell Rowell
Paul Christman
Maj. John J. Orr
Franklyn A. Buck
LCdr. Louis L. Nicholson, Jr.
James W. Willis
Charles H. Newcomer

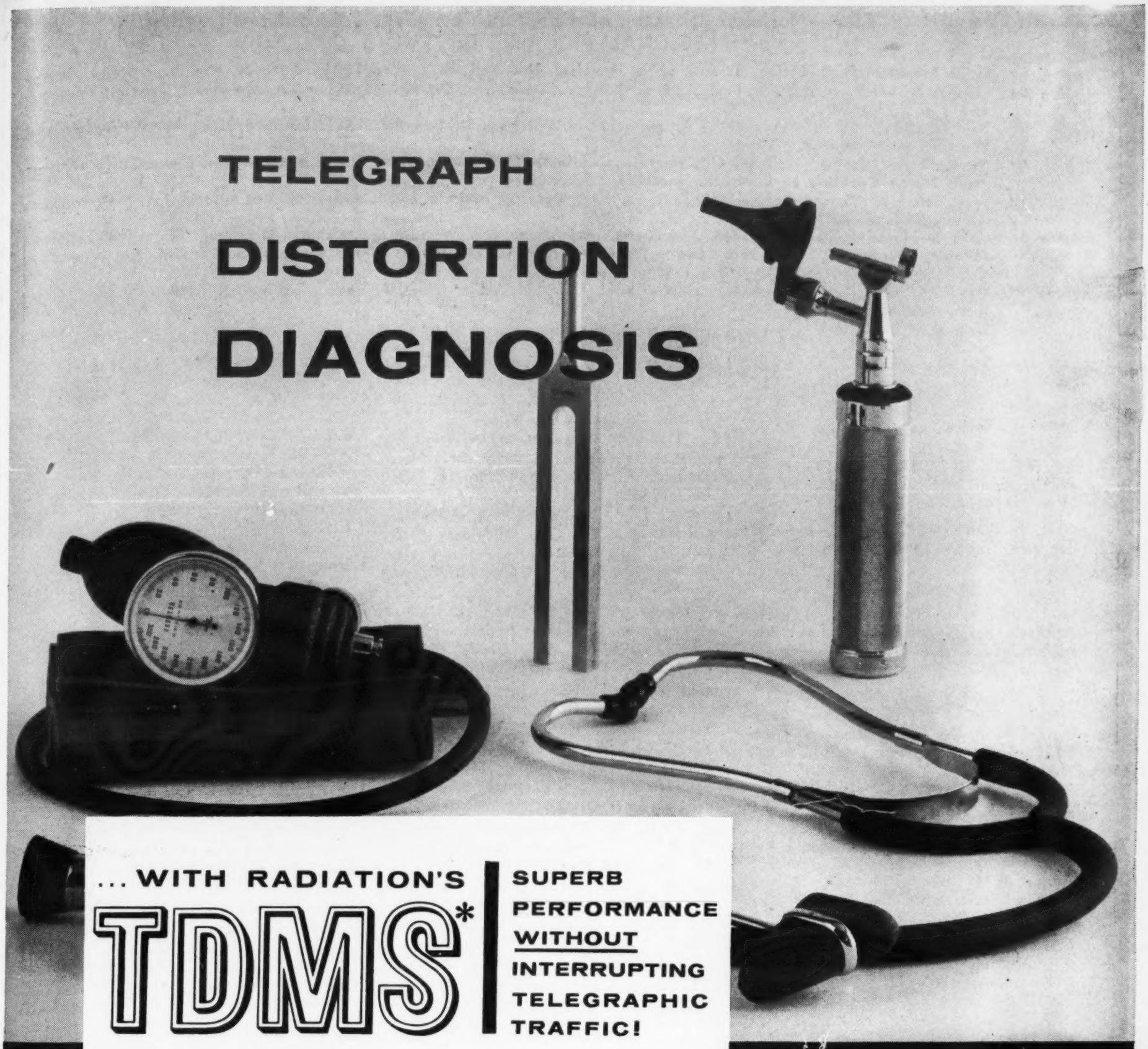
NEW MEMBERS WITHOUT CHAPTER AFFILIATION
W. A. Cunningham, Cleveland, Ohio
Paul F. McCarville, Milwaukee, Wisc.

AFCEA Group Members

Communications—Electronics—Photography

Listed below are the firms who are group members of the Armed Forces Communications and Electronics Association. By their membership they indicate their readiness for their share in industry's part in national security. Each firm nominates several of its key employees or officials for individual membership in AFCEA, thus forming a group of the highest trained men in the electronics and photographic fields, available for advice and assistance to the armed services on research, development, manufacturing, procurement, and operation.

Acme-Danneman Co., Inc.
Admiral Corp.
Aircraft Radio Corp.
Allied Control Co., Inc.
Allied Radio Corp.
American Cable & Radio Corp.
American Institute of Electrical Engineers
American Machine & Foundry Co.
American Radio Relay League
American Telephone & Telegraph Co.
American Telephone & Telegraph Co., Long Lines Dept.
Ampex Corp.
Amphenol/Borg Electronics Corp.
Anaconda Wire & Cable Co.
Andrew Corp.
Arnold Engineering Co.
Atlas Film Corp.
Atlas Precision Products Co.
Automatic Electric Co.
Automatic Electric Sales Corp.
Automatic Telephone & Electric Co., Ltd.
Autonetics, Division of North American Aviation, Inc.
Barry Controls, Inc.
Beiser Aviation Corp.
Bell & Gossett Co.
Bell Telephone Company of Pa.
Bell Telephone Laboratories, Inc.
Bendix Radio Division, Bendix Aviation Corp.
Bliley Electric Co.
Bomac Laboratories, Inc.
British Thomson-Houston Co., Ltd.
Bruno-New York Industries Corp.
Burroughs Corp.
California Water & Telephone Co.
Cambridge Thermionic Corp.
Capitol Radio Engineering Institute, Inc.
Carolina Telephone & Telegraph Co.
Central Technical Institute
Chesapeake & Potomac Tel. Co.
Cincinnati & Suburban Bell Tel. Co.
Collins Radio Co.
Columbia Broadcasting System, Inc.
Contraves Italiana
Convair, Division of General Dynamics Corp.
Cook Electric Co.
Copperweld Steel Co.
Cornell-Dubilier Electric Corp.
A. C. Cossor Ltd.
Craig Systems, Inc.
Crosley Division-Avco Mfg. Corp.
Designers for Industry, Inc.
Diamond State Telephone Co.
Dictaphone Corp.
DuKane Corp.
Du Mont, Allen B., Laboratories, Inc.
Eastman Kodak Co.
Electronic Associates, Inc.
Electronic Communications, Inc.
Elgin Metalformers Corp.
Fairchild Camera & Instrument Corp.
Federal Telecommunication Laboratories
General Analysis Corp.
General Aniline & Film Corp.
General Communication Co.
General Electric Co.
General Telephone Corp.
Gilfillan Bros., Co.
Globe Wireless, Ltd.
Gray Manufacturing Co.
Hallamore Electronics Co.
Haller, Raymond and Brown, Inc.
Hallicrafters Co., The
Haloid Xerox Inc.
Hazeltine Electronics Division, Hazeltine Corp.
Heinemann Electric Co.
Hoffman Laboratories, Inc.
Hogan Laboratories, Inc.
William F. Hogan Associates, Inc.
Hughes Aircraft Co.
Illinois Bell Telephone Co.
Indiana Bell Telephone Co.
Indiana Steel & Wire Co.
Institute of Radio Engineers
International Business Machines
International Resistance Co.
International Telephone & Telegraph Corp.
International Telephone & Telegraph Laboratories
ITT Federal Division of International Telephone & Telegraph Corp.
Jacobsen Manufacturing Co.
Jansky & Bailey, Inc.
Jerrold Electronics Corp.
Kellogg Switchboard & Supply Co.
Kleinschmidt Laboratories, Inc.
Leich Sales Corp.
Lenkurt Electric Co.
Lewyt Manufacturing Corp.
Litton Industries, Inc.
Lockheed Aircraft Service, Inc.
Machlett Laboratories, Inc.
Magnavox Co.
Marconi's Wireless Telegraph Co. Ltd.
Materiel Telephonique Co.
Michigan Bell Telephone Co.
Montgomery Co., The
Motorola, Inc.
Mountain States Telephone & Telegraph Co.
Mullard Ltd.
Muter Co.
National Co., Inc.
Nelson Technical Enterprises, Inc.
Nems-Clarke Co., Div. of Vitro Corp. of America
New England Tel. & Tel. Co.
New Jersey Bell Telephone Co.
New York Telephone Co.
North Electric Co.
Northwestern Bell Telephone Co.
Oak Manufacturing Co.
Ohio Bell Telephone Co.
O'Keefe & Merritt Co.
Otis Elevator Co., Electronic Division
Pacific Mercury Television Mfg. Corp.
Pacific Telephone & Telegraph Co.
Packard-Bell Electronics Corp.
Page Communications Engineers, Inc.
Phelps Dodge Copper Products Corp.
Philco Corp.
Photographic Society of America
Plessey Co., Ltd.
Prodelin Inc.
Radiation, Inc.
Radio Corporation of America
Radio Corporation of America, Defense Electronic Products
RCA Great Britain, Ltd.
Radio Engineering Laboratories, Inc.
Ramo-Wooldridge, Division of Thompson Ramo Wooldridge Inc.
Raytheon Manufacturing Co.
Red Bank Division, Bendix Aviation Corp.
Reeves Instrument Corp.
Rocke International Corp.
Saxonburg Ceramics, Inc.
Singer Manufacturing Co., The Military Products Division
Smith-Corona Marchant Inc., Research and Development Division
Society of Motion Picture & Television Engineers
SoundScriber Corp.
Southern Bell Telephone & Telegraph Co.
Southern New England Telephone Co.
Southwestern Bell Telephone Co.
Sperry Gyroscope Co., Division of Sperry Rand Corp.
Sprague Electric Co.
Stackpole Carbon Co.
Standard Telephones & Cables, Ltd.
Stanford Research Institute
Stewart-Warner Corp.
Stoddart Aircraft Radio Co.
Stromberg-Carlson Co., Division of General Dynamics Corp.
Surprenant Mfg. Co.
Sylvania Electric Products, Inc.
Technical Materiel Corp., The
Tele-Dynamics, Inc.
Telephonics Corp.
Teletype Corp.
Texas Instruments, Inc.
Times Facsimile Corp.
T.M.C. (Canada) Ltd.
Transitron Electronic Corp.
Trans-Sonics, Inc.
Triad Transformer Corp.
Tung-Sol Electric, Inc.
Union Carbide Corp.
United Shoe Machinery Corp.
United Telephone Co.
United Transformer Co.
Van Norman Industries, Inc., Electronics Division
Waterman Products Co., Inc.
Webster-Chicago Corp., Government Division
West Coast Telephone Co.
Western Electric Co., Inc.
Western Union Telegraph Co.
Westinghouse Electric Corp.
Weston Electrical Instrument Corp.
Wheelock Signals, Inc.
Wilcox Electric Co., Inc.
Willard Storage Battery Div., Electric Storage Battery Co.
Wisconsin Telephone Co.
Wollensak Optical Co.
Zenith Radio Corp.



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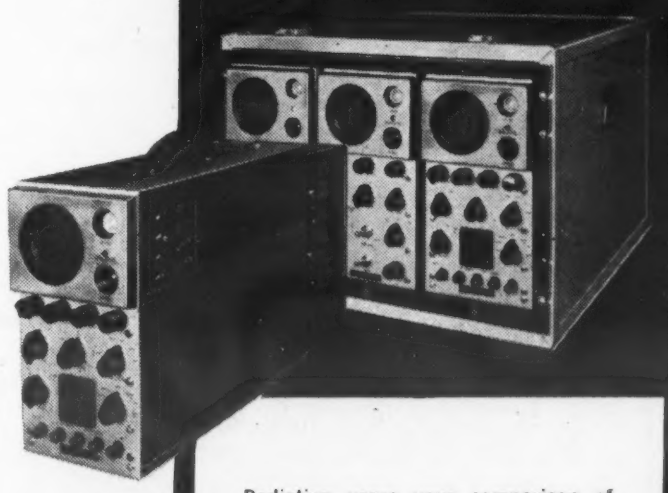

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Region B2: Paul H. Clark, Radio Corporation of America, 224 N. Wilkinson St., Dayton, Ohio. ***Kentucky, Ohio, West Virginia and Western Pennsylvania.***

Region C: W. K. Mosley, Southern Bell T&T Co., Hurt Bldg., Atlanta, Ga. ***Southeastern States along Atlantic and Gulf coasts—from North Carolina to Louisiana including Tennessee.***

Region D: Maj. Gen. Harry Reichelderfer, USA (Ret.), Southwest Research Institute, 8500 Culebra Rd., San Antonio, Tex. **New Mexico, Texas, Oklahoma, Arkansas.**

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PHILADELPHIA: Pres.—Frank D. Langstroth, Philco Corp., 22nd St. & Lehigh Ave., Philadelphia, Pa. Sec.—Conrad Young, Philco Corp., 4700 Wissahicken Ave., Philadelphia.

PHILIPPINE: Pres.—Lt. Col. Sidney A. Goldman, 1961st AACS Sqdn, APO 74, S. F. Sec.—Capt. Roy L. Stover, 1961st AACS Sqdn, APO 74, S. F.

PITTSBURGH: Pres.—Robert C. Ridley, Copperweld Steel Co., Glassport, Pa. Sec.—H. W. Shepard, Jr., 625 Stanwix St., Pgh.

ROCKY MOUNTAIN: Pres.—Col. Howard S. Gee, Hqs. ADC, Ent AFB, Colo. Sec.—Lt. Col. Michael E. Wardell, Hqs NORAD, Ent AFB, Colo.

ROME-UTICA: Pres.—William L. Roberts, 102 Fort Stanwix Park North, Rome, N. Y. Sec.—A. D. Reisenberg, Box 107, Griffiss AFB, N. Y.

SACRAMENTO: Sec.—Capt. Robert McMorrow, 951 La Sierra Drive.

SAN DIEGO: Pres.—Cmdr. Samuel Freedman, Chemalloy Electronics Corp., Gillespie Airport, Santee, Calif. Sec.—Mrs. Dolores R. Stover, Western Union, 135 So. Orange, El Cajon, Calif.

SAN FRANCISCO: Pres.—J. T. Chatterton, Mackay Radio & Tel. Co., 350 Mission St., San Francisco, Cal. Sec.—Carroll V. N. Steffen, Pacific T&T Co., 74 New Montgomery St., S. F.

SAN JUAN: Pres.—Kenneth M. Barbier, Radio Corp. of P. R., Box 3746, San Juan, P. R. Sec.—Albert R. Crumley, Standard Elec. Corp. of P. R., Box 11156 F. Juncos St., Santurce, P. R.

SCOTT-ST. LOUIS: Pres.—B. Roger Robards, Southwestern Bell Tel. Co., 721 Missouri Ave., E. St. Louis, Ill. Sec.—Allan L. Eisenmayer, P.O. Box 456, Trenton, Ill.

SEATTLE: Pres.—Lee David, 4609 W. Oregon St., Seattle, Wash. Sec.—J. Alan Duncan, 6836 - 29th Ave., N.E., Seattle.

SOUTH CAROLINA: Pres.—William O. Kiger, Southern Bell T&T Co., Columbia, S. C. Sec.—F. L. Davis, Southern Bell T&T Co., Owen Bldg., Columbia.

SOUTH TEXAS: Pres.—Col. Will D. Joslin, SigSec, Hq. 4th U. S. Army, Fort Sam Houston, Tex. Sec.—Maj. Vincent Grzegorowicz, 634 Infantry Post, Fort Sam Houston, Tex.

SOUTHERN CALIFORNIA: Pres.—John W. Inwood, Western Union, 745 So. Flower St., Los Angeles. Sec.—David G. Soergel, North American Aviation, Inc., 9150 E. Imperial Hwy, Downey, Cal.

SOUTHERN CONNECTICUT: Pres.—John N. Higgins, KIP Electronics Corp., 29 Holly Pl., Stamford, Conn. Sec.—J. A. Leopold, Dictaphone Corp., 375 Howard Ave., Bridgeport.

SWITZERLAND: Pres.—Capt. Gerald C. Gross, USNR, Intl. Telecommunications Union, Geneva. Sec.—Robert V. Lindsey, Intl. Telecommunications Union, Geneva.

TINKER-OKLAHOMA CITY: Pres.—Col. William L. Gregory, Hqs Continental AACS Area, Tinker AFB, Okla. Sec.—Capt. James D. Porter, 3rd AACS Sqdn. (Mob), Tinker AFB.

TOKYO: Pres.—Capt. Frank A. Dingfelder, Staff, Cdr. Naval Forces Japan, FPO S. F., Cal. Sec.—Cdr. Harold B. Kirkham, Naval Comm. Facility, Navy 830, Box 20, FPO, S. F.

WASHINGTON: Pres.—John R. O'Brien, Hoffman Labs, Inc., 1625 Eye St., N. W., Washington, D. C. Sec.—A. W. Christopher, Jr., Sylvania Electric Products, Inc., 734-15th St., N.W.

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Chapter News

Arizona

The U. S. Forestry Service furnished the program for the January 13th meeting. The dinner-meeting, which was also ladies' night, was held at the Fort Huachuca Officers Open Mess and drew an excellent attendance.

Mr. M. Jiras of the Forestry Service showed two interesting movies—one illustrated the destructiveness of a forest fire caused by carelessness, and the other showed the trees that have been planted on the White House lawn by various Presidents of the United States.

During the business session, Lt. Col. William M. Coeyman, former vice president, was elected to the presidency of the chapter, and Lt. Col. Hanford T. Colwell was elected vice president.

Baltimore

The chapter's annual U. S. Marine Corps-sponsored meeting took place on January 15th. The host was the local Marine Corps Engineer Reserve Battalion, with the meeting held in its new Armory.

Maj. Gen. Henry R. Paige, USMC, Assistant Chief of Staff, G-4, was guest speaker, with "The Concept of Marine Corps Operations and the Types of Electronic Equipments Needed to Support these Operations" as his subject.

The program also included a message from Representative James Devereux (Brig. Gen., USMC, Ret.), a guided tour of the new Armory (which features the latest in design and facilities), selections by the Marine Corps Battalion Band, demonstrations by a Marine Drill Team, and a display of the latest electronic and communications equipment from the Development Board at Quantico.

Master of ceremonies during the dinner-meeting was Col. Charles L. Cogswell, USMCR, a vice president of the chapter.

Boston

The latest methods of air traffic control were discussed by Bruce McCaffery of the Raytheon Manufacturing Company at the January meeting, held at the Boston Naval Shipyard Officers Club.

Mr. McCaffery's presentation, augmented by slides, also covered the new CAA-approved Air Route Surveillance Radar being developed and produced by Raytheon.

Fort Monmouth

Walter Wiesman, Communication Advisor at the U. S. Army Ballistic Missile Agency, Redstone Arsenal, gave an authoritative talk on "The Missile Program" as guest speaker at the chapter's January 15th dinner-meeting at Gibbs Hall Officers Club.

Mr. Wiesman, now an American citizen, was one of the group of German V-2 specialists who came to the United States in 1945. Since then, he has occupied management staff positions with the Ordnance Guided Missile Center, the Redstone Arsenal and the Army Ballistic Missile Agency. His current responsibility is the development of a number of orientation and information programs connected with missiles and satellites.

Kansas City

On January 22nd, the chapter heard an address by Robert A. Bounds, Facility Chief, Central Altitude Reservation Facility, on the assignment and control of routes and altitudes for movement of air traffic in the continental United States. The CARF is a branch of the new Federal Aviation Agency.

Mr. Bounds detailed the duties and responsibilities of the FAA which regulates both civilian and military aircraft, not only while the aircraft is in the air but also while it is being manufactured. These include: manufacturing inspections, flight tests, qualified crew and navigational aid requirements, airport inspections, etc.

The operation of the thirty air control centers in the U. S. is another FAA responsibility. Flight plans must be filed with the applicable control center well in advance of the departure of aircraft so that the center can assign routes and altitudes to the pilot and inform him of any other pertinent data necessary for a safe flight. The air control center also notifies and gets clearance from other control centers through which the plane will pass. As the aircraft comes into the jurisdiction of another air control center, the pilot notifies the center and is given flight information.

The speaker also told the group that the facilities of FAA are used most effectively by such branches of the armed forces as SAC, TAC, ADC, Navy, etc., in making their mock attacks. He further pointed out that radar is another safety factor which has great potentialities and that plans are now being formulated by the FAA for handling commercial jet aircraft.

Mr. Bounds conducted a question and answer period at the conclusion of his talk. The dinner-meeting was held in the Wishbone Restaurant. President L. E. Eastmond introduced special guests, Harry Cooper, past president of AFCEA's Scott-St. Louis Chapter, and Col. Don Meserve, past president of the Kansas City Chapter.

London

Maj. Gen. R. J. Moberly, C.B., O.B.E., Signal Officer-in-Chief, British War Office, was the guest speaker at the January 15th meeting. Members and their guests met at the USAF Columbia Club in London, with a social hour and dinner preceding the formal program.

General Moberly related many interesting experiences which had happened in his thirty-three years as a military communicator and then described the numerous problems confronting the Signal Officer of today. "Continued mutual understanding and support between industry and the Armed Forces of both our countries is of the utmost importance," he stated.

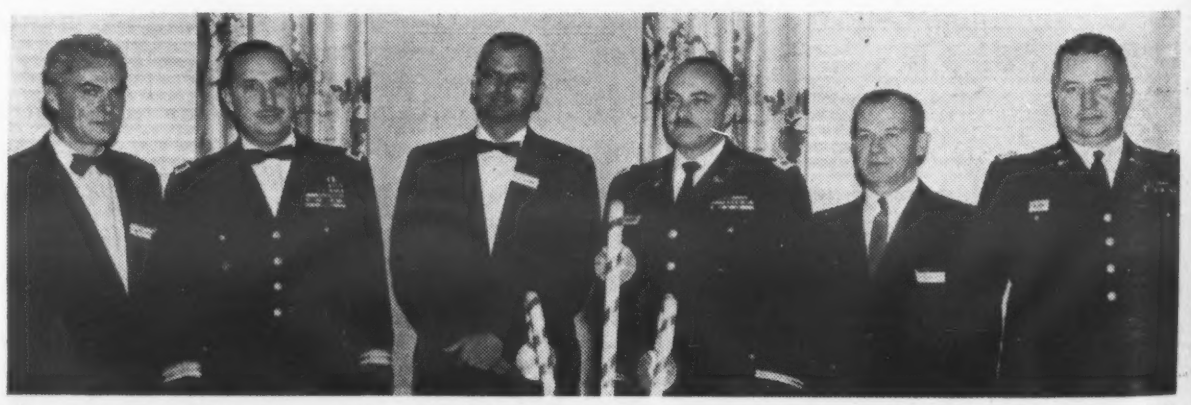
Louisiana

"The Strategic Air Command's World Wide Communication System" was the subject at the chapter's January 15th meeting. The speaker was Col. Virgil R. Sewell, USAF, Second Air Force (SAC), Barksdale Air Force Base, La.

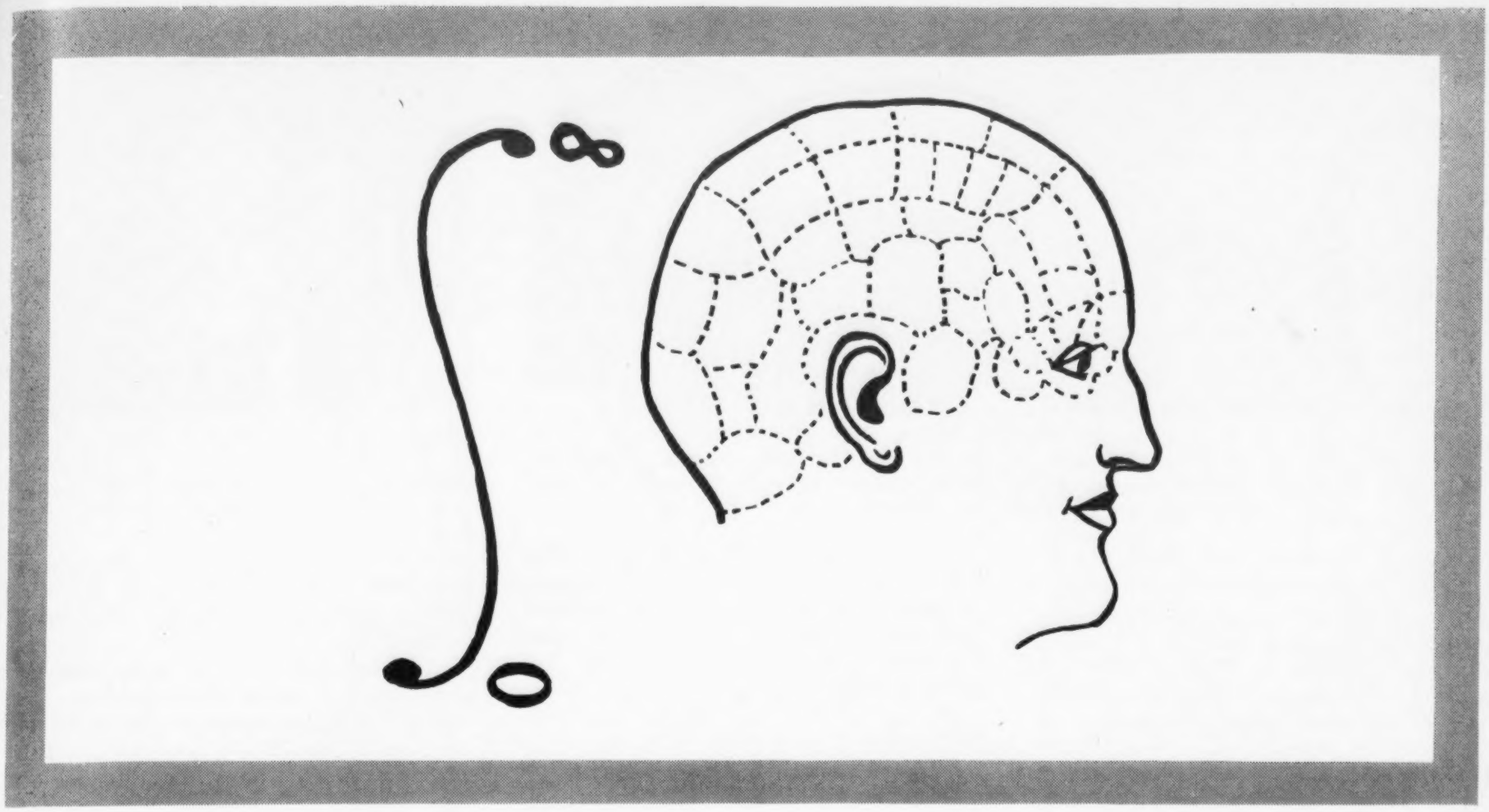
Members and guests met at the Naval Air Station Commissioned Officers Mess for a social hour and dinner prior to the meeting.

Philadelphia

The AFCEA chapter and the local section of IRE held a joint meeting at the Franklin Institute on January 14th to hear famed Dr. I. M. Levitt, Director of The Fels Planetarium of the Franklin Institute, discuss "A Closed



Augusta-Fort Gordon—New chapter officers, who were recently installed for 1959, are, left to right: L. C. Phillips of Southern Bell T&T Co., first vice-president and national council member; Brig. Gen. David P. Gibbs, USASTC, national council member; E. L. Lynch of Southern Bell, treasurer; Col. Robert R. Creighton, USASTC, president; Otto Lechman of RCA, second vice-president, and Lt. Col. Ollie J. Allen, USASTC, secretary.



Knowledge: The Constant Variable

No phase of man's activity is subject to greater range of variability than brainpower. As knowledge increases, so does our nation's capacity to wage peace or war and all conditions between. As technological education goes, so goes industry—and the armed services.

Since 1927, when we offered the first advanced course in practical radio engineering, CREI has been dedicated to increasing its store of electronics knowledge. To perceive the brainpower needs of industry and the armed services in our chosen field of technical electronics education; to meet those needs effectively; to keep pace with changing, expanding techniques and disciplines; to interpret theory in terms which can be mastered by technicians; these are our objectives. Comments and actions by disinterested observers lead us to conclude that we are meeting our self-chosen obligations.

CREI educational facilities include:

• **Home Study Division.** World-renowned school of advanced electronic engineering technology. On a student-hour basis, the study record of this division is the equivalent of a residence technological school with a full-time enrollment of 1,500 students.

• **Residence School.** Provides the very best in technical education for future professional electronics personnel in the armed services and industry.

• **European Division.** London branch opened in July, 1958, to make advanced professional electronic education available abroad.

• **CREI Atomics.** Devised to meet the growing need for advanced home study education in Nuclear Engineering Technology for engineering and technical personnel in industry, government and military services.

• **Holmes Institute.** Leadership training to help management in its search for healthy attitudes of cooperation and leadership.

• **Automation and Industrial Electronics Engineering Technology.** A newly added complete home study course covering all phases of automation; includes fundamentals, leading to specialization in machine control, data processing, servomechanism and telemetry systems; industrial processes, digital and analogue computers, instrumentation techniques.

For information about our educational services, write E. H. Rietzke, President.
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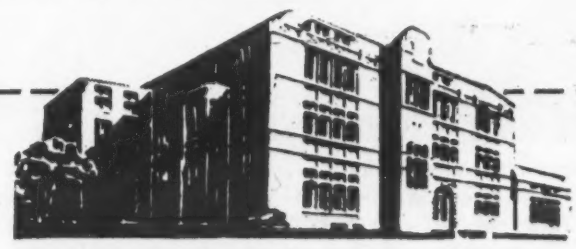

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***London**—Shown at the head table at the January 15th meeting, are, left to right: Col. J. A. Plihal, USAF, chairman of the meeting and chapter vice-president; Maj. Gen. R. J. Moberly, C.B., O.B.E., Signal Officer-in-Chief, British War Office, who was the guest speaker, and Maj. C. L. Bachtel, USA, chapter vice-president.*

***Philadelphia**—Dr. I. M. Levitt, director of The Fels Planetarium of The Franklin Institute, who addressed a joint AFCEA-IRE meeting on January 14th.*

Ecological Cycle on the Moon."

Based on the continuance of a $6 billion dollar a year expenditure, Dr. Levitt believes that man will actually land on the moon by 1980. When this landing takes place, he feels that it will be possible to establish a community on the moon to explore space and to furnish the tools for reconnaissance of the solar system. Thus, with its potential ability to be made into a supply base, the moon assumes major military significance. It appears that the first man on the moon, who can assemble the necessary materials to survive, will own the moon. If a critical material is found on the moon, limited in supply, then only the first man will be able to maintain himself indefinitely, while others cannot. This puts a high premium on getting to the moon first.

What can man expect to find when he finally lands on the moon? Dr. Levitt firmly believes that energy will be most abundant and least expensive on the moon. This will come from the fission of the heavy weight radioactive elements or from the fusion of the hydrogen atom. If we can bring the efficiency of solar cells to 35%, the sun can supply the energy to help transform the moon from the bleak body we know it today into a flourishing civilization. From the rocks on the moon will come an atmosphere, water and hydrogen for fuel. By combining the many chemicals available in rocks, man will also be able to derive rocket fuels, dyes, polymers, medicinals, plastics, textiles, building materials, synthetic oils, etc., Algae will provide food, and be used additionally to process the waste material of the human organism.

Dr. Levitt does not believe that the scientist is the man to send on early trips to colonize the moon. Instead, he feels that the technicians, craftsmen, engineers and communications experts are the people to lay the ground work for those who follow. In about two decades, Dr. Levitt projects that the moon will not be recognizable for the bright reflections from the plastic-domed villages there. Man has changed the earth—his next target is the moon.

Dr. Levitt recommends a long-overdue full-scale program to study the moon if we are to look upon it as a military objective.

Prior to this address, Dr. Levitt was awarded a citation by Philip Klein, representing the Mayor of Philadelphia, for his outstanding contributions as an educator, writer and scientist. Dr. Levitt was also appointed an Honorary Deputy and presented a Civil Defense Badge.

Pittsburgh

Chapter members toured the studio and transmitter plant of Station WIIC on January 20th and saw the complete working of the television studio.

At 8 o'clock there was a color pick-up from New York which gave the group an opportunity to see what happens to the picture as it comes over the telephone wires and then is transmitted from WIIC.

An hour later, the members watched a complete program rehearsal, with the action being televised on the monitors, the corrections made, and adjustments of the cast.

Rome-Utica

The chapter's December 17th meeting was reported in the *Rome Daily Sentinel* as follows:

"Somebody tagged this the 'beat generation'." He could have done it better if he had called it the generation of change. Because if there is anything that marks these times it is change.

"Examples of what we expect because of electronics were demonstrated last night at a combined dinner-meeting at The Beeches of the Rome-Utica Section of IRE and the Rome-Utica Chapter of AFCEA.

"We in this country have not only been exposed to so much that is new within the range of our perceptions, such as hi-fi music for the ear, but there are experiments along certain lines that make possible the hearing of sounds previously unknown to man.

"And this can mean that in other fields, besides hearing, there are things waiting to be perceived that we still know nothing about.

"Dr. Cyril N. Hoyler, Manager of

***Rome-Utica**—Reuben O. Schlegelmilch, second from right, chairman of the Rome-Utica Section of IRE, operates one of RCA's latest electronic developments—a micro-miniature television camera; Explaining the device and its workings with the dummy is Dr. Cyril N. Hoyler, manager of technical relations for RCA's David Sarnoff Research Center, who addressed a combined AFCEA-IRE meeting on December 17th, attended by about 250. Looking on at left are Col. Charles W. Gordon, USAF(Ret.), far left, chairman of the day, and Brig. Gen. Donald P. Graul, commander of RADC. AFCEA Executive Vice President W. B. Goulett is at right.*

Technical Relations for RCA's David Sarnoff Research Center at Princeton, N. J., spoke for almost an hour and a half on results of experimentation.

"Some of the wares on display would make a 'Buck Rogers' of 'Alley Oop.' There was a walkie-talkie transmitter and receiver, the size of a pack of matches; a radio receiver that could be a fountain pen in your shirt pocket; a camera for shooting live television shows that's the size of a best-seller novel.

"Slides showed a refrigerator that worked without any moving parts. Cold was formed when a current passed through dissimilar metals.

"Dr. Hoyler displayed a light amplifier, featuring experimentation of electronics in solids (as compared to electronic movement in a vacuum, such as a radio vacuum tube). A dim image projected onto one side of the amplifier became brighter on the other side. A practical implication would be with X-rays, since an effective X-ray could be made with less radiation.

"He displayed an electronic highway system for controlling cars on the road, and finally operated an electronic device for making sounds—over a trillion of them—and combining some of these sounds into music.

"Col. Charles W. Gordon (USAF, Ret.), manager of the local RCA Field Office, was chairman and introduced the speaker. Reuben O. Schlegelmilch, chairman of the IRE section, and William L. Roberts, president of the AFCEA chapter, presided.

"Dr. Hoyler had high praise for both local chapters of the world-wide scientific groups, noting that they are among the best in the world."

Scott-St. Louis

"The Air Materiel Command Logistic Management Concept" was the subject of a talk by Lt. Col. Herbert E. Greuter, USAF, Chief, St. Louis Air Procurement District Office, Air Materiel Command, before the chapter's January 9th dinner-meeting at Augustine's Restaurant in Belleville.

As an introduction, Colonel Greuter defined "logistics" in terms of its Greek derivation and in terms of its present meaning. He presented a complete picture of the Air Materiel Command, its sub-commands, areas, mission, etc.

Describing the logistics structure of AMC, Colonel Greuter pointed out that, although the logistics mission never changes, throughout the years and history of warfare, the manner in which the mission was or is accomplished is dependent on current weapons, force structures, and new concepts and techniques.

The speaker also emphasized that military competition between nations now appears to be at the development rather than at the mass production level, as was the case during World War II, and that now the emphasis is on "minimum time between the identification of a need and the initial operational capability."

Seattle

Featured speaker at the January 14th chapter meeting was Herbert H. Arlowe, Engineer-in-Charge, 14th District, FCC.

Mr. Arlowe opened his remarks by going into the history of radio and communication as they effectively related to the ultimate formation of the FCC. He pointed out the following:

"The first governmental control of wireless communication began with the Wireless Act of 1910 which made wireless aboard certain vessels compulsory. The enforcement of this Act became the responsibility of the Department of Commerce. The ensuing years brought an increase in the force of the Department of Commerce and it exercised ever-increasing authority. In 1926, a case went through the courts and it was determined that the Department of Commerce lacked the authority to regulate land radio communications.

"In 1927, the Federal Radio Commission was formed and given proper authority to regulate and govern radio transmissions. Then, in 1934, the Federal Communications Commission was formed. Because of the tremendous change in the field of communications during World War II, it was necessary in 1946 to reorganize the FCC and further enlarge the scope of its operation." Mr. Arlowe then discussed the size and scope of the present Commission, its field offices, and the various agencies which have additional interest in FCC activity.

By citing a hypothetical case, the speaker pointed up the steps and offices involved in licensing a TV station. Through very broad generalities, the types of complaints received by the FCC were discussed and mention was made of the usual methods employed to satisfy the complaints. The assistance offered by the local "TVI Committee" was lauded and the function of the "Cooperative Interference Committee" was explained.

Mr. Arlowe augmented his well-received informal discussion with some very interesting color-slides showing some of the field stations and equipment and illustrating some rescue operations in which the FCC played important roles.

South Carolina

The Chapter met on January 22 at Shaw Air Force Base in the Officers Open Mess, with 125 members and guests in attendance.

The evening's program was presented by R. G. Elliott, Vice President-Staff Operations, Southern Bell Telephone Company, Atlanta. Mr. Elliott's lecture-demonstration was entitled "Things to Expect in the Future."

One of the highlights of the evening was Mr. Elliott's demonstration that television pictures can be transmitted over telephone station circuits during a regular telephone conversation. Preparations prior to the program included equipping a telephone on another part

South Carolina—R. G. Elliott, Vice President—Staff Operations, Southern Bell T&T Co., Atlanta, who presented a lecture-demonstration at the chapter's January 22nd meeting.

of the Base with the necessary television camera, and installing a 24-inch television set on the telephone line in the Officers Mess. After Mr. Elliott dialed a number in the normal manner, the AFCEA audience was able to hear the conversation and to see the distant party on the 24-inch screen. Although not commercially feasible now, Mr. Elliott numbered this among the future services telephone users could expect.

As part of a demonstration of direct distance dialing, Mr. Elliott dialed Admiral (Ret.) Frederick R. Furth, National President of AFCEA, in New York, who addressed the meeting over the telephone by means of a loudspeaker.

Mr. Elliott also had a number of other developments, such as an automatic dialer, the transistor, a solar battery, etc., which he discussed with the group. Of particular interest were his predictions of possible future services the telephone industry may offer.

The props used by Mr. Elliott were displayed so that AFCEA members could examine them more closely after the meeting.

The Chapter's new 1st vice president, Col. John H. McVey, was introduced to the group. He succeeded Col. H. N. Sturdivant, who has retired.

Special guests at the meeting included W. G. Edwards, Vice President and General Manager for Southern Bell in South Carolina; Raymond Sheehan, Vice President and General Manager for the General Telephone Company of the Southeast; Maj. Gen. D. W. Hutchison, Commander, 9th Air Force; Col. Gerald J. Dix, Commander, Shaw Air Force Base; Col. Thomas R. Ford, Commander, 837th Air Division; and Col. Robert C. Bagby, Deputy Commander, 354th Tactical Fighter Wing, Myrtle Beach Air Force Base.

AFCEA Executive Vice President W. B. Goulett was also guest of the chapter and gave a brief report to the members on Association affairs.

Southern California

"Adventures in Science" was the subject of the December 1st dinner-meeting in the Golden State Room of the Statler Hotel, Los Angeles. This was also

LET'S COUNT BACK FROM THE COUNTDOWN

This is the "moment of truth." This is the countdown. A satellite will soar into the stratosphere. A rocket will hit or encircle the moon.

But let's count *back* from the countdown.

Let's count the grueling tests, the check-outs. Let's count the months of manufacturing, the skill, precision and care that went into each of the thousands of parts.

Let's count the brain-power, the engineering talents of the brilliant men at work . . . the modifications and refinements in design . . . the "breakthroughs" that had to be made.

Let's count all the way back to the first gleam of concept in a scientist's probing, inventive mind.

And let's not forget to count the administrative control, the guidance, the coordination and planning that go into these complex projects.

There's a new name for it

Such involved systems of engineering and automation demand an entirely new concept of planning, research, specialized administration and technical coordination. It is called "system management." It places complete responsibility for every phase of a giant project in the hands of one company or group of companies.

It takes tremendous resources. In manpower. In administrative capacity. In facilities. And that is why ITT has been selected for projects of the highest importance. The ITT System operates and maintains the DEW Line, and is managing the production of a new world-wide electronic control system ingeniously conceived by the Strategic Air Command for its operations.

And ITT is deep in many other vital projects.

In industry, too, there are "countdowns"

Large industrial projects, too, need system management. Vast communication networks, for instance . . . linking continents through "over-the-horizon" microwave . . . world-wide air-navigation systems . . . the development of automation in industrial processes.

System management has great potential. And ITT is equipped to put it to work . . . to assume full responsibility for complete system management projects anywhere in the free world. This includes not only basic concept, engineering and manufacture . . . but also installation, testing, operation and maintenance.

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Southern California—The head table and some of the 150 members and guests present at the December meeting are shown above, as Chapter President John W. Inwood of Western Union welcomes the gathering. "Adventures in Science" was the subject of the evening's program.

ladies night, with over 150 members and guests present.

The first guest speaker was Dr. L. C. VanAtta of Hughes Aircraft, who told of the excellent work of the Southern California School Industry Education Council in association with the National Academy of Sciences directed toward assisting local educational groups in their efforts to improve the quality of engineering graduates in this country.

The Southern California Council acts as a clearing house of information, stimulates the formation of new local councils, publishes a Newsletter which has a distribution of some 1500 and holds an Annual conference. The organization consists of a Board of Directors of 60 representatives from industry and education and an Executive Committee elected by the Board from its membership. There are Program, Membership, Finance and Public Information committees, among others, to advance its work. As one indication of the rapid growth in the program, Dr. VanAtta pointed out, students in the Los Angeles city schools during the 1958 spring semester participated in over 12,500 student hours of lecture-demonstrations in 18 of the city's 35 high schools. This activity was matched in Orange and San Diego counties, where different programs, keyed to local needs, have been pushed.

Also guest speakers were Tom Roberts and Lew Teeter from the General Electric Company who presented a variety of interesting demonstrations reflecting the steady progress of scientific advancement. The show had recently been adapted to the missile age and most demonstrations were concerned with fundamentals of propulsion, guidance, and fiight dynamics. The GE show is a direct industry effort to interest high school level students in pursuing scientific careers.

Tinker-Oklahoma City

At its January 15th meeting, the chapter voted to sponsor AFCEA student memberships for the top science or electronics student in each of the ten Oklahoma City High Schools and the Midwest City High School. Del Cravens of Southwestern Bell Telephone Co., chairman of the School Activities Committee, reported that arrangements would be made for each of these students to attend the chapter's meetings as a guest of a regular member.

Maj. John L. Whyatt, 3rd AACS Squadron (Mobile) was appointed secretary to fill the unexpired term of Capt. James D. Porter who was being transferred overseas.

The principal speaker of the evening, William F. Main of the Missile System Division, Lockheed Aircraft Corporation, presented, in layman's language, a technical discussion of the problems and future of "Space Communications."

Mr. Main said that, at present, the bandwidth available for earth-to-space communications is very narrow—limited by the air of earth, the heat of the earth, and the noise of the galaxy—and that improvement of equipment and technique offers only slight increase in the range possible in the band of frequencies that can be used from earth. He felt that better technique of information discrimination can extend the range to the nearer planets. However, weight limits imposed on the vehicle carrying the space end of the communications system limit the power available and will prevent greater ranges from earth. Mr. Main stated that he did not feel that earth-to-deep-space communications would prove economically feasible with earth-based transmitters, hazarding a guess that the present cost of a three-minute earth-to-moon conversation would be about $1,000.00 (on a commercial basis) if the installation could be made.

The best hope, expressed by Mr. Main, is based on the fact that, once clear of the atmosphere and ionosphere of earth, the limits of frequency are not so severe. Relay satellites offer a real possibility for deep space communications where light (infra-red to UV), X-ray or even gamma ray frequencies could be used.

At the conclusion of the talk, M. Brentnall, Chief of Sales, Missile Systems Division, Lockheed, presented a color film showing the progress of air equipment developed by the Lockheed Corp. since the highly successful P-38.

An open question and answer session was conducted at the close of the meet-

Washington—Maj. Gen. Stanley T. Wray, USAF, Commander, Wright Air Development Center, (center) addresses the January 6th luncheon-meeting at the Willard Hotel. His subject was "Satellite Capabilities." Seated at the head table are, left to right: Col. Bascom R. Lawrence, Brig. Gen. Robert G. Ruegg, Brig. Gen. John B. Bestic, Brig. Gen. H. A. Boushey, Maj. Gen. Harold W. Grant, Chapter President John R. O'Brien, Maj. Gen. William T. Thurman, Paul Goldsborough and Brig. Gen. Robert P. Taylor.

"THE MILITARY REQUIREMENTS FOR MOON BASE"
This is the title of one of four major proposals developed within the past 12 months by Martin for the military and astroscientific branches of our Government. The importance of this proposal is two-fold: the inevitability of an actual moon base program by this country within the next 5 years, and; we could and can undertake such a project now — not in theory but in "hard" engineering design. In preparation for that inevitability, Martin already has built the capability for it. One important step was the creation of the Space Flight Division*, which is now directing Phase 1 of Project DYNA-SOAR.

*The Space Flight Division is one of the 7 divisions of Martin

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ing by Messrs. Main and Brentnall and F. F. Homstad, Manager of the Oklahoma City office of Lockheed's Georgia Division.

Washington

The Evening Star reported the chapter's January 6th meeting at the Willard Hotel, as follows:

"The Air Force X-15 rocket ship may begin its first short, stabbing flights into the edge of space next month—carrying man farther from earth than ever before.

"Maj. Gen. Stanley T. Wray, Commander of the Wright Air Development Center, indicated this at a luncheon meeting yesterday of the AFCEA.

"Gen. Wray in his formal talk said merely the North American X-15 would make its first flight soon, as the only manned vehicle to reach out into space.

"The early flights will be on the conservative side while the pilot feels out the craft's performance. But eventually it is expected the X-15 will probe altitudes of 100 miles or more and venture into velocities of five to seven times the speed of sound—3,200 to 4,500 mph.

"The faster and highest flights by man so far were made by the Bell X-2 in 1957—2,178 miles an hour and 126,000 feet—about 24 miles—altitude.

"Gen. Wray was reminded that Scott Crossfield, assigned to pilot the X-15 on its first flights, told reporters at Los Angeles last fall there was a possibility of an initial flight before the end of 1958.

"The general replied that there had been some problems in connection with the rocket engine and the early optimism had not been realized. He said he did not look for the flights to begin this month.

"The X-15 will be launched at high altitude from beneath a B-52 bomber mother ship. When the 20-minute, full-range flights get under way, the craft will be launched over Wendover, Utah, and will land on a desert lake bed at Edwards Air Force Base, Calif."

Guests at the head table were: Chaplain (Brig. Gen.) Robert P. Taylor, Deputy Chief of Air Force Chaplains; Paul Goldsborough, Director for Telecommunications Policy, Office Assistant Secretary of Defense (S&L); Maj. Gen. William T. Thurman, Assistant for Production Programming, Deputy Chief of Staff/Materiel (AF); Maj. Gen. Harold W. Grant, Director of Communications-Electronics, Deputy Chief of Staff/Operations (AF); Brig. Gen. Robert G. Ruegg, Director, Procurement & Production, Deputy Chief of Staff/Materiel (AF); Brig. Gen. H. A. Boushey, Director of Advanced Technology, Deputy Chief of Staff/Development (AF); Brig. Gen. John B. Bestic, Deputy Director of Communications-Electronics, Deputy Chief of Staff/Operations (AF); and Col. Bascom R. Lawrence, Deputy Director of R&D, Deputy Chief of Staff/Development (AF).

The Singing Sergeants, official chorus of the U. S. Air Force, presented a brief program.

NEW PRODUCTS FROM INDUSTRY

Silvercel "Space" Battery

A small lightweight, power-packed battery, the Yardney Silvercel battery, developed by Yardney Electric Corporation of New York City, has had an important role in recent space probes. With six times more power than equal size-weight conventional batteries, it has successfully supplied power for telemetering and flight and guidance controls in the second stage of the *Pioneer*. Its temperature range of —40° to +165°F assures good performance under the extreme conditions encountered in outer space. The ability to discharge at high rates and still maintain relatively high voltage, to withstand severe shock, vibration and acceleration, to be discharged in any position, and to require minimum maintenance all make it extremely useful in missiles, rockets and torpedoes where highly efficient power, light weight and small size are paramount factors.

UHF TV Translator Amplifier

Communities shielded from originating TV stations and beyond the range of 10 watt translators are now able to receive TV service. This is due to a translator-amplifier (type RA-7) that provides 100 watts of peak visual output power in the 470-890 mc frequency range when driven by a suitable modulated UHF TV signal.

Developed by Adler Electronics, Inc. of New Rochelle, N. Y., the broadband amplifier features variable bandwidth, full metering, a self-contained power supply and an exclusive method of adjusting the position of the feed point along the cathode line to insure proper drive impedance and extremely low VSWR.

Miniaturized Linear Ball Bushings

New manufacturing techniques in component miniaturization now enable the production of extremely miniscule linear ball bearings that will effect major reductions in both the size and weight of critical instruments in missiles and aircraft.

These new Ball Bushings (designated INST-258 and INST-396), developed by Thomson Industries, Inc. of Manhasset, Long Island, are under one inch in size and under one ounce in weight. However, despite small size, each bearing contains three complete ball circuits and possesses the super-sensitive characteristics of the larger Bushings, each bearing individually tested for sensitivity. They are rugged in construction and capable of withstanding high vibrational and shock loads. The precision manufacturing techniques, combined with the antifriction rolling design, assure minimum static and rolling friction together with a high degree of reliability and repeatability.

Their use, in place of ordinary friction type sleeve bearings in military aircraft and guided missile applications, increases the chances for optimum performance. Among the varied applications are: the latest guidance, fire control and navigation systems, computers and inertial devices.

Lint-Free, Non-Contaminating Garments

After months of experimentation, a glove that would not generate any lint, dust or fiber, would prevent contamination by perspiration, skin oils and chemicals and yet would not interfere with the manual dexterity of the wearer, was created by Victor Gloves, Inc. of New York City. Designed in collaboration with the Bell Telephone Laboratories, they are now being used in the hand assembly of select devices sensitive to physical and chemical contamination.

As a result of their success, Victor Gloves has developed a complete line of lint-free, non-contaminating garments including coveralls, shoe covers, head covers, slip-on smocks, trousers and special garments made to individual requirements. They are particularly effective in plants making a wide variety of items where cleanliness is a factor in reliability.

Krypton Nuclear Battery

The availability of a Krypton battery reported to produce an output potential greater than 5 KV in a volume less than one-quarter of a cubic inch and to be free from radiological ingestion hazard, has been announced by Radiation Research Corporation of New York City.

The battery operates on the same principle as that of Strontium 90, which is that beta particles penetrating a solid dielectric are collected as electrical energy. The dielectric used in Krypton batteries is the same radiation-improved dielectric previously used in long-lived Strontium batteries. However, due to the highly toxic nature of Strontium 90, the radioisotope Krypton 85 has been substituted for it. Krypton is said to be not metabolized in any way by the body, therefore rendering batteries using Krypton hazardous only if unshielded. If a Krypton battery is accidentally opened, the Krypton dissipates harmlessly into the atmosphere.

Operating in a temperature range from —175° to +165°F, the battery possesses the ability to withstand violent mechanical shock, vibration and acceleration. Its applications are varied and include energy storage units, electric detonator power sources, radiation detection instruments, timing devices and outer space power sources.

Analog Data Multiplexer

Remote "real-time" recording, computing, simulating or control are made practical by coupling a new multiplexer, developed by the Geotechnical Corp., of Dallas, Texas, directly to a single voice-frequency telephone, radio or microwave circuit to transmit several channels of analog data long distance.

From 1 to 8 adjustable and serviceable voltage-controlled FM subcarrier oscillators may be plugged into the multiplexer. The standard EIA rackmounted multiplexer is 8¾" high x 19" wide x 15" deep, and weighs 30 pounds.

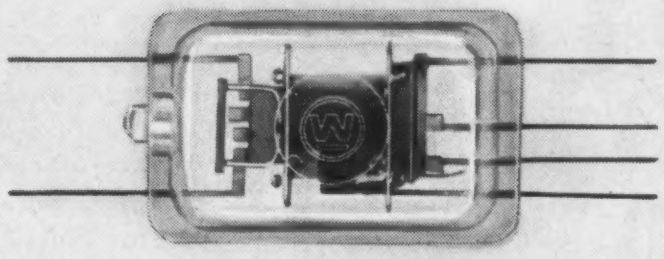
The standard multiplexer, Model 3515, will transmit 7 analog data channels, 1 reference frequency channel and a full-duplex communications channel, with additional channels possible. System accuracy is ± 1%.

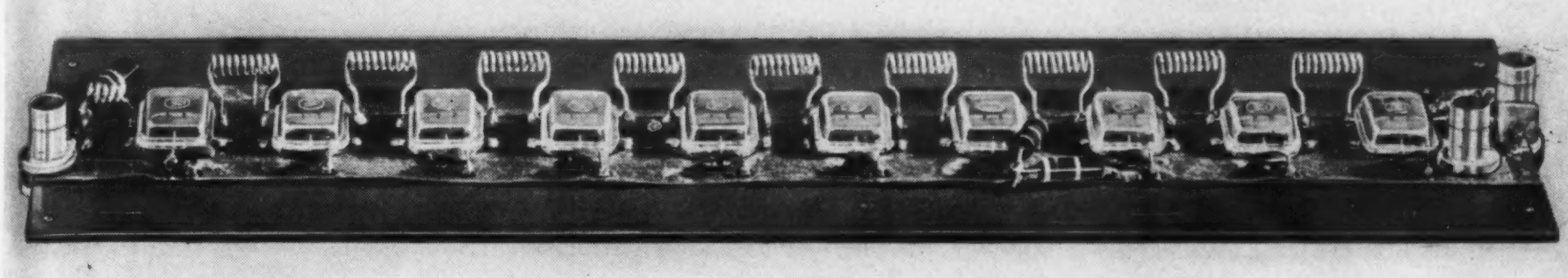
Contactors and Relays

Designed by the Rowan Controller Co., a new line of special purpose contractors and relays is available to the public. Description of these new products is provided in a 16-page booklet containing engineering and cataloging on the Type B and BR contactor and on the Type R and F relays. Of particular interest to the computer, power supply and electronic industries, designs for the air conditioning, heating and refrigeration areas are also offered.

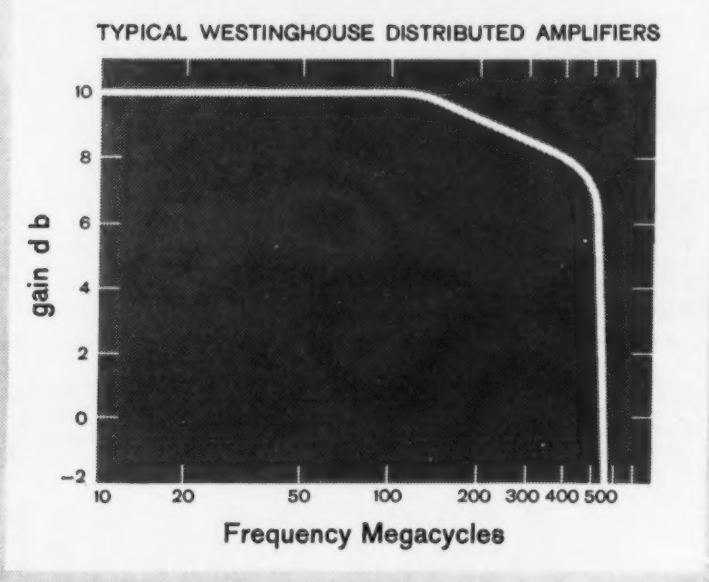
Further information and copies of the bulletin may be obtained from the Rowan Controller Company, 2313-2315 Homewood Avenue, Baltimore 18, Md. (*Continued on page* 84)

Westinghouse tube engineering...
serving the nation through imagination





GAIN AT HIGHER FREQUENCIES



with Westinghouse distributed amplifiers

The new Westinghouse Match Box Tubes provide distributed amplifiers with response to 550 MC.

Match Box tubes surpass conventional tubes in high frequency performance and resistance to vibration. Tubes lie flat . . . no height problem . . . eliminates sockets, fits printed circuits.

Westinghouse Distributed Amplifiers can be designed with various frequency pass bands. They're especially suited for electronic counter-measure circuits and for high-speed, high-frequency oscilloscopes. We'd welcome the opportunity to design and build your Distributed Amplifiers.

CHARACTERISTICS WX3683

Heater 6.3 Volts	0.2 amperes
Plate current	8 milliamperes
Transconductance	5100 micromhos
Plate Voltage	180 volts

Write for complete information.

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Mass Communications for Korea

The need for low cost mass communications, so vital to the survival of every culture, became strikingly evident to Dr. Byung Woo Kong, a noted Korean eye surgeon, in 1944 as he arduously began to translate by hand numerous medical textbooks into the Korean language. He then conceived and began to develop the idea for Korean typewriters, teletypewriters and typesetters. These efforts eventually resulted in a Korean typewriter, a combination Korean-English typewriter (both built by Smith-Corona), an adaptation of the Korean keyboard to the Kleinschmidt teleprinters used by the U.S. Army Signal Corps, and a typesetting machine for the mass production of low cost newspapers and books on which he is now hard at work.

The first problem encountered in the development of the typewriter was to devise a means to adapt the standard typewriter keyboard to the Hangul language. The Korean alphabet is phonetic, consisting of fourteen consonants, ten vowels and fifteen additional characters called "sub-consonants." For keyboard purposes the basic characters are designated as consonants, double consonants, sub-consonants and vertical and horizontal vowels, any three of which may appear in two spaces to produce a syllable or word. The consonants appear above the center of the type line, while the sub-consonants are typed directly below with the horizontal vowels falling between. Several characters are identical, except for position on the line, being placed above, below or between other letters. The problem of subconsonants was solved by placing them on "dead" keys which do not advance the carriage.

In his design of the combination Korean-English portable typewriter, Dr. Kong employed essentially the same method. Each type pallet contains an English and Korean character. Depressing the shift key produces the Korean character, and the carriage advances normally for English characters.

Medical Electronic System for Space Flight

With the launching of man in space vehicles impending, "we must make all haste to learn just how severe the physiological stresses are which they will be undergoing," according to an official of Gulton Industries, Inc., Metuchen, N. J. For this purpose a 20-pound package of medical instruments that will measure the physiological condition of man in space has been developed by the Vibro-Ceramics Division of Gulton.

Six physiological parameters can be measured which will reveal useful information about blood pressure, heart rate, heart sounds, respiration rate and depth, skin temperature from many points on the body and galvanic skin resistance. All equipment is designed to operate in extreme environmental temperatures, as well as under acceleration conditions of up to several times the force of gravity.

Tunable Reject Filter

A development program aimed at combining two techniques (broad band hybrids and tuned cavities) to obtain both single-frequency and dual-frequency band-pass and band-reject filters in the microwave region has resulted in a new device introduced by Radar Design Corporation. The first such product to emerge from this program, the device is a tunable band reject filter for the 2 - 4 KMC range. The reject filter is described as one that passes all frequencies in this range except a small band of frequencies selected by a micrometer adjustment. (*Continued on page 86*)

NEW NEW

AMCI COAXIAL SWITCHES

Type 1038 for use in 6⅛" lines

and now Type 1136 for use in 3⅛" lines

AMCI TYPE 1038-R SHOWN

For use in Rigid Coaxial Transmission lines at VHF and UHF

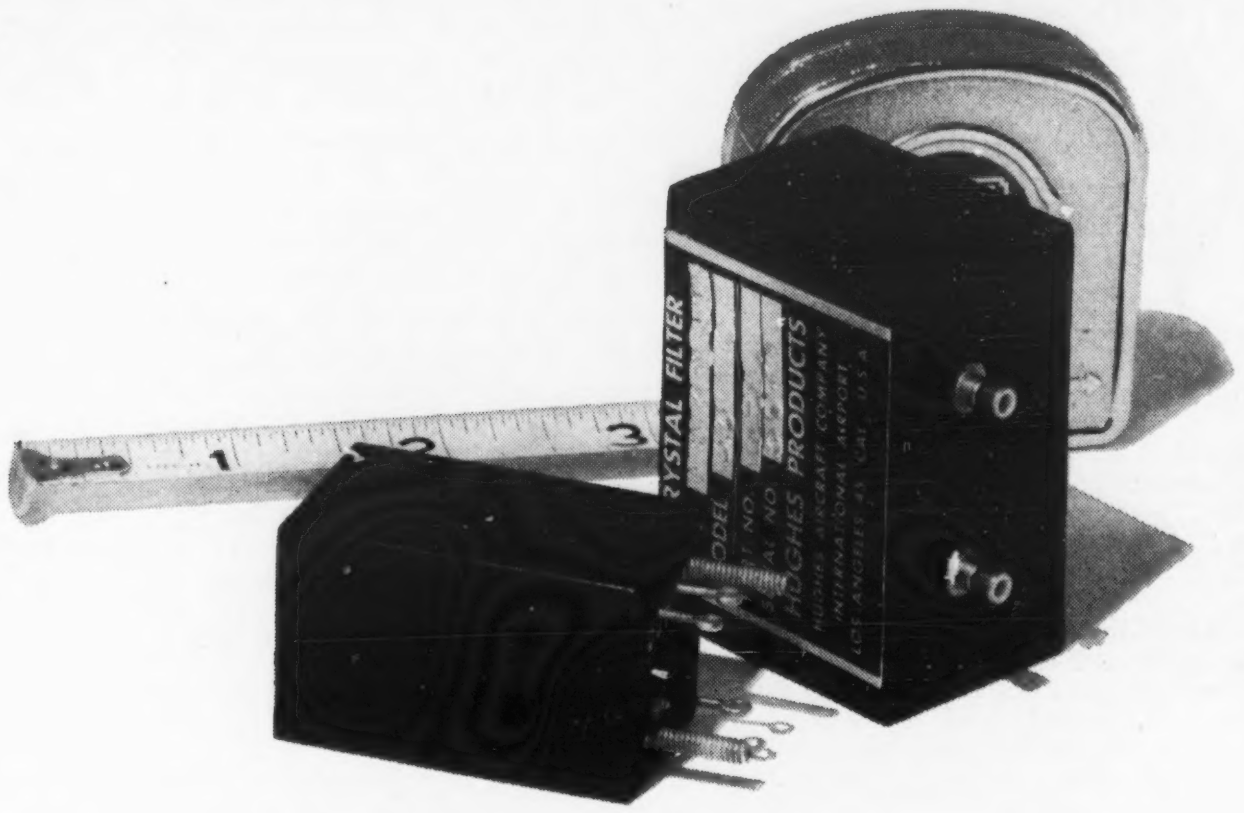
- VSWR is under 1.05 over rated frequency range: 0-450 mc for the Type 1038 6⅛" Coaxial Switch; 0-500 mc for the Type 1136 3⅛" Coaxial Switch.
- CW rating is approximately that of the mating transmission lines.
- Switches are available in either motor-driven or manually operated models.

Write for complete information on AMCI Coaxial Switches

ANTENNA SYSTEMS – COMPONENTS – AIR NAVIGATION AIDS – INSTRUMENTS

AMCI ALFORD Manufacturing Company

299 ATLANTIC AVE., BOSTON, MASS.



PRECISION PERFORMANCE LEVELS set by Hughes Crystal Filters

Now you can obtain high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unobtainable.

These crystal filters have center frequencies of 30 kc to 30 mc. In addition, you can take advantage of seven distinct features:

1. High frequency filtering
2. High selectivity
3. Low passband ripple
4. Low insertion loss
5. Small size and weight
6. Excellent temperature stability
7. Excellent shock and vibration stability

A complete engineering service for network and filter design is available to you. To obtain specifications for crystal filter types currently available, or for information concerning engineering capabilities, please write: Hughes Products, Marketing Dept., International Airport Station, Los Angeles 45, California.

TYPICAL BANDPASS FILTERS DELIVERED BY HUGHES PRODUCTS

	No. 1	No. 2	No. 3
Center Frequency	30 mc	10 mc	6 mc
6 db bandwidth	170 kc	40 kc	2 kc
60/6 db bandwidth ratio	1.35	2.3	1.4
Minimum Stop-band Attenuation	60 db	60 db	60 db
Maximum Passband Ripple	±1 db	±0.6 db	±0.75 db

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

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National Electronics
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Electronics Men Procurement
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Since 1942

Imbedded Printed Wiring

A process of printed wiring for miniaturization of electronic equipment that offers high reliability of performance under environmental extremes such as temperature, humidity, vibration and altitude is the "Beck Process" developed by Beck's, Inc. of St. Paul, Minnesota. The process is one in which the metallic circuit is imbedded in the laminate or base material. Either flush or fully imbedded circuitry can be fabricated. The circuitry can be formed by any one of several methods: etching, forming, metallic spray or metal deposition.

Portable Ground Tester of Aircraft Navigational Equipment

Rapid ground testing of military or civil airborne navigation equipment, while it remains undisturbed in an aircraft, is accomplished by a portable test set now in regular production at the ITT Federal Division of ITT Corp., Clifton, N. J. The set operates by transmitting to the plane under test, distance- and direction-measuring signals simulating those broadcast by certain navigation stations. It makes possible the testing of both the distance- and direction-measuring equipment of the military's airborne TACAN and the distance-measuring equipment of the VORTAC civil air navigation system.

The set (Type NUS3156) weighs 20 pounds, is easily portable and may operate within a range of from 6 to 60 feet from the aircraft. Measuring 10½" high, 8" wide and 11¾" deep, it may be used with standard aircraft power supply outlet (115 volts ac, 50 to 1,000 cps). No direct connection to the aircraft is necessary due to special antenna attached to the set.

New FM Radio Terminal

Constant contact with separated construction operations is made possible by the new compact Type 896 FM Radio Terminal introduced by Radio Engineering Laboratories of Long Island City, N. Y.

Up to six simultaneous toll-quality conversations from suitable multiplex equipment may be handled by the terminal. Transmitter, receiver and power supply are housed in a single relay rack-mounted enclosure 35 inches high and weighing 110 pounds. Frequency range is normally 148-174 mc; transmitter power is 50 watts; radio gain is 119 db; receiver noise figure is 7 db, and the terminal is engineered for high reliability.

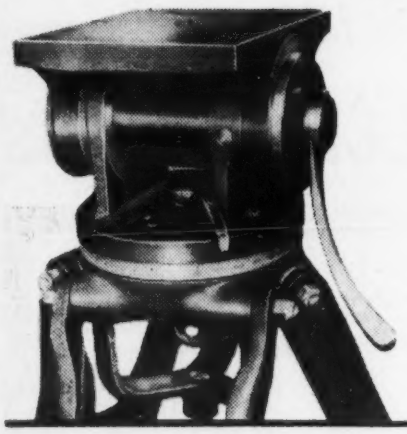
Data on Radiation Monitoring

New information on the characteristics and usage of Kodak films employed to monitor radiation in the fields of modern industry, science and medicine has been published by Eastman Kodak Company. A twenty-page booklet, *Radiation Monitoring with Kodak Personal Monitoring Films*, outlines the photographic method of obtaining accurate and permanent records of the radiation dosage incurred by individuals and by specific areas.

It also provides information on the four types of Kodak film used for these purposes and includes new data on calibration and processing considerations. The films described are designed primarily to be worn by individuals in monitoring badges. Kodak Personal Monitoring Film—Types 1 and 2 measure x-, gamma and beta-radiations, while Types A and B are neutron monitoring films.

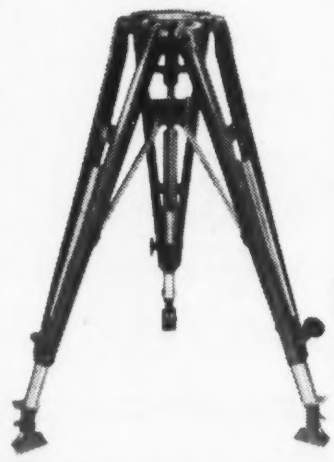
Illustrated with line drawings and graphs, free copies of the booklet (P-31) may be obtained from Special Sensitized Products Sales Division, Eastman Kodak Company, Rochester, N. Y. (*Continued on page* 89)

CECO microwave relays
conquer space barriers



Whether it's a fixed station or a mobile unit, CECO microwave equipment surmounts the communication barrier. Because CECO equipment is built to a quality that is actually higher than the official standards. For dependable pickup and relay under adverse climatic conditions, you're wise to play safe with CECO.

Micro Wave Relay Beam Reflector Head
Perfect for parabolas up to 6-ft. diameter. Withstands torques of 225 ft. pounds in elevation and 150 ft. pounds in azimuth. Environmental treated for extreme weather conditions.
$ 285.00 Relay Tilt Head Only



ALL METAL TRIPOD
Has cast top flange and upper leg portion made of one piece aluminum alloy castings. Legs slide easily and have tie-rods to center for automatic leveling. Accepts Balanced TV Head, Micro Wave Relay Beam Reflector Head (illus.) and other similar professional tripod heads. **$260.00** Metal Tripod only.

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RELIABILITY IN MINIATURIZATION

ACEPOT®-500 ACEPOT X-500*

Sub-miniature, linear and non-linear potentiometers. Single turn unit, ½" size, ±2% resistance tolerance and ±0.3% ind. linearity.

actual size

Size	½" x ½"
Weight	0.25 ounce
Resistance Range	2Ω to 500K
Resistance Tolerance	±2%
Linearity	±0.3% Ind. standard
Temperature*	−55°C to 125°C*
Mechanical Rotation	Continuous or with stops
Electrical Angle	325° std. ≷ available
Resolution	0.12% for 50 K Others comparable
Torque**	.05oz./in. at 20°C (Bronze) .035oz./in. (Ball bearing)
Power	2W for 60°C rise or 2.5W for 65°C (X-500)
Mounting	Threaded bushing, servo, flush or flanged. Ganged up to 6 cups.

* X-500 standard high temperature potentiometer. Range: −55°C to 150°C.

**Jewel bearing Acepot torque of .014 ounce/inch.

ACEOHM®

Sub-miniature trimmers . . . high temperature, humidity proof for severe environment.

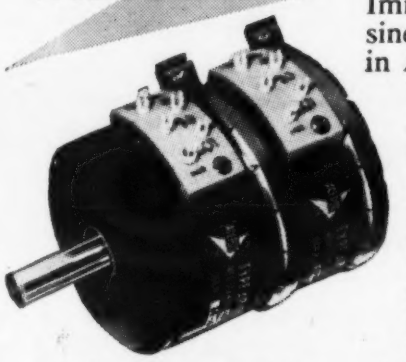
actual size

Size	1¼" x ¼" x 5/16" Standard Mounting holes
Weight	0.2 ounce
Resistance Range	10Ω to 75K — Special to 150K
Mechanical Rotation	25 Turns on lead screw, adjustable over 100% of winding
Power Rating	1.6W at 40°C Derates to 0 at 225°C
Temperature Range	−55 to 225°C
Resolution	.13% for 75K. Other resistances comparable
Dielectric Strength	1000 volt DC for 60 sec.
Load Life	1000 hours at 180°C
Capacitance	Extremely low distributed capacity (moulded hi temp. phenolic case & cover)

Completely sealed element. Meets and surpasses all applicable requirements of MIL-E-5272A and MIL STD. 202A.

ACEPOT®

Standard non-linear and linear potentiometers. 0.25% terminal conformity with out padding resistors. Immediately available in sine, cosine, square law and log functions in AIA sizes.



Typical Spec's:

	Sine-cosine	Double Sided Square-law
Size	3"	3"
Resistance	20K ±5% driving	25K ±5% driving
Conformity	½% pk-pk	±0.25%
Function angle	360°	±180°
Power	4 watts	3 watts
Mounting	Servo	Servo

Submit your design requirements to our Engineering Group for evaluation and quotations.

ACESET®

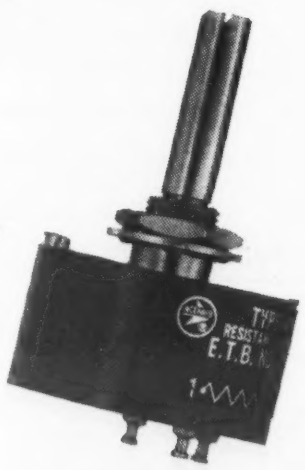
Sub-miniature Trimmers. Heat dissipation . . . 2 watts at 60°C. Immediate delivery in resistances of 50Ω to 50 K.

actual size

Size	½" x 5/16"
Weight	⅓ ounce, including lock washer and nuts
Resistance Range	50Ω to 100K ±10% std. tol.
Linearity	±5%
Temperature Range	−55°C to +125°C
Mechanical Rotation	330° Nominal
Electrical Angle	320° Nominal
Power	2 watts for 60°C. rise
Mounting	¼"-32 threaded bushing

ACEMHO*

Conductive plastic element. Infinite resolution. Extremely long life. No sudden open-circuit failure possible. Low, low noise. Meets JAN & MIL specs.



Size	1 5/16"
Weight	1.6 ounce
Resistance	to 5 megohm
Linearity	.5% Independent
Resolution	essentially infinite
Power	2W at 20°C
Mounting	Bushing

*Reg. applied for

ACETRIM®

Sub-miniature trimmers . . . A wide range of resistances are available in this low-cost, space and weight saving unit.

actual size

Size	½" x ½"
Weight	0.25 ounce
Resistance Range	2Ω to 250K ±5% std. tol.
Linearity	±3%
Temperature	−55°C to 125°C (to 150°C (X-500)
Mechanical Rotation	continuous or with stops
Electrical Angle	325° std. ≷ available
Power	2W for 60°C rise or 2.5W for 65°C
Mounting	Threaded bushing, printed circuit, flush, flanged, ganged.

Exact requirements for your particular applications, can be custom designed and mass produced with short lead time. All units are anti-fungus treated and fully sealed against dust, moisture and humidity. Meets applicable JAN-MIL specs including shock and vibration. Send us your specifications for engineering assistance on designs and applications. Complete Fact File and Application Data Sheets available on request. CALL, wire or teletype Dept. S-3 at Ace Electronics Associates, Inc., 99 Dover Street, Somerville, Mass. SOmerset 6-5130, TWX SMVL 181.

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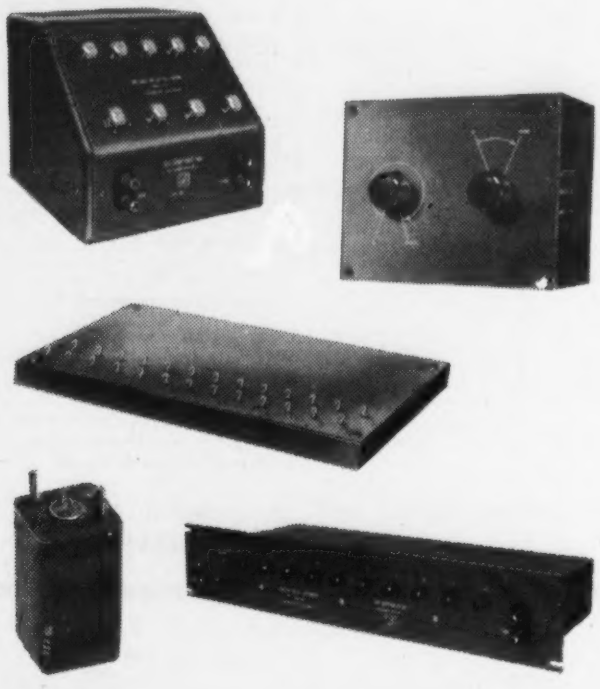

- *1st in sales*
- *1st company devoted exclusively to the manufacture of custom-built delay lines*
- *1st in research, design, development of custom-built delay lines, variable delay lines, continuously variable delay lines*
- *1st to submit the most definitive laboratory reports with all prototypes*

ESC is the manufacturer of the remarkable Delay Line Model 51-43 – a totally new Delay Line with a 145 to 1 delay-to-rise-time ratio. Write for complete data.

CUSTOM-BUILT and STOCK PULSE TRANSFORMERS

medium and low-power transformers
filters of all types • pulse-forming networks
miniature plug-in encapsulated circuit assemblies

Every prototype delay line and pulse transformer report you receive from ESC includes submitted electrical requirements, photo-oscillograms (which indicate input and output pulse shape and output rise-time), the test equipment used, and an evaluation of the electrical characteristics of the unit. You can be sure that ESC specifications are at once realistic and economical, particularly aimed at eliminating costly, time-consuming overspecification.

Write today for literature and technical data.

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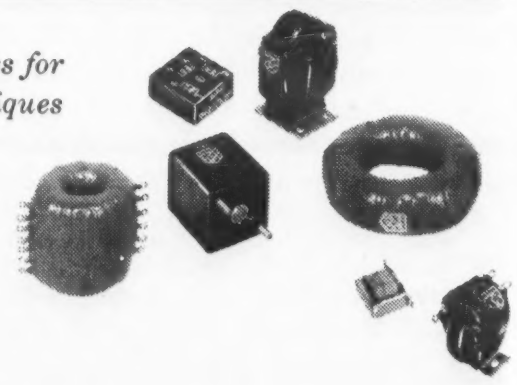

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Semiconductor Bibliography

Semiconductor units today are finding their place wherever reliability, long life, small size, ruggedness and low voltage operation are required. With this constantly increasing expansion in the technology of the solid state, comprehensive bibliography and reference listings are becoming more and more essential.

Newmarket Transistor Company Ltd. has recently published *Fifteen Years of Semiconducting Materials and Transistors,* an extensive bibliography with over 2500 references. This is a second and revised issue of an edition published five years ago when the fact that "a vast field of application existed for solid state devices could only be implied."

For further information, contact Newmarket Transistor Company Ltd., Exning Road, Newmarket, England.

Portable Telescoping Antenna Mast

After fifteen years of government and industry effort, a pneumatically operated telescoping microwave antenna mast has been developed. The first practical portable antenna mast, a major advance for Army field communications is described in a 4-page bulletin, published by I-T-E Circuit Breaker Company and is the fourth in a series of reports on antenna system and waveguide engineering accomplishments.

The bulletin describes the design and performance features of the new mast which is 20 feet high and can be raised automatically to 50 feet. The new performance features are: stability—holds a microwave antenna beam on direction with only a plus or minus ¾ of a degree shift in a 60-mile wind; portability—can be carried in five compact packages and completely assembled and erected in 30 minutes; all-weather operation—if jammed by ice, the fully extended mast can be lowered or raised through a gin pole arrangement incorporated in the base; rapid operation and mechanical lock-up—the mast telescoping section can be extended or retracted in three minutes and each section is automatically locked in extended position through a positive mechanical latching system.

Power for the mast is supplied by an electric motor-driven air compressor. The controls, all at the base, include those for main power, mast pressure, telescoping direction, antenna elevation and antenna azimuth.

For copies write the I-T-E Circuit Breaker Company, 1900 Hamilton St., Philadelphia 30, Pa.

The Last Days of Sputnik II

As a part of Project Space Track, activity by the Air Force directed at tracking artificial earth satellites and space vehicles, a report has just been released that traces the path of Sputnik II during the two weeks immediately prior to its disintegration.

Observations were collected from observers and stations in all parts of the world. They include such data as positions of the satellite on the celestial sphere and velocity in the line of sight. In addition to these observations, the study includes descriptive reports dealing with the decay-phenomena as observed during the last phase of the re-entry from ships and islands in the Caribbean.

The report, PB 151249, *Project Space Track: The Orbital Motion of the Earth Satellite 1957 from 1 April 1958 to its Decay 14 April 1958,* may be obtained from OTS, US Dept. of Commerce, Washington 25, D. C., for $1.25.

Spiral-4 Connector

Recently, the Army Signal Corps introduced a new, lightweight, aluminum, field replaceable Spiral-4 connector, a vital link in telephone-teletype carrier systems. These carrier systems, with their Spiral-4 cable transmission medium, allow tranmission of several messages (12 voice channels or up to 192 teletypewriter channels) over a single circuit.

According to T. E. Miller and R. deSante of the U.S. Army Signal Equipment Support Agency, Fort Monmouth, N. J., there is hardly a facet of military communications in the Army that does not use this "strategic" Spiral-4 cable.

Mr. Miller and Mr. deSante were the project engineer and coordinator on the improved Spiral-4 connector.

"Its use encompasses such operations as Communication Centers in Army, Corps, Division and Combat Group Headquarters and interlinking units, interarea runs in Nike systems and many others," they reported.

The cable includes 4 conductors with polyethylene core and insulation, a stainless steel braid used for shielding and tensile strength and a vinyl case in an over-all diameter of ⅜". For flexibility of installation, it is constructed in lengths of ¼ mile, 100 feet and 12 feet.

The present Spiral-4 cable, provided with brass connectors molded to the cable, was introduced into the military system during the Korean Conflict to increase the voice channels from 4 to 12, completely replacing the pre-Korean Spiral-4 cable.

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VHI- 8	10.	15.	100	.85
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MCV-6130F	95-130 v	60 cps.	6.4	130
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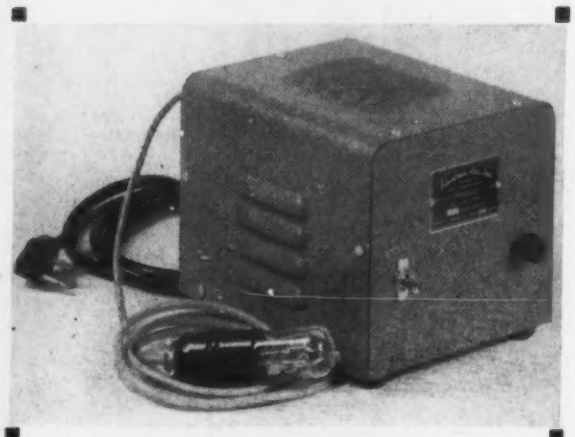

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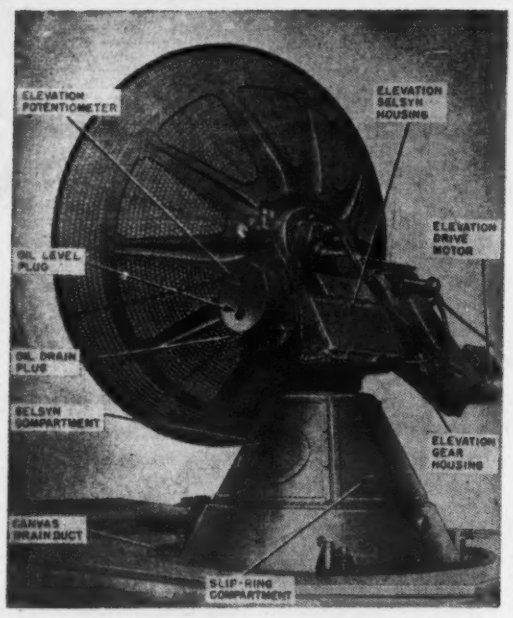

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and provide necessary links for all telephone and telegraph carrier communications circuits. Over 150,000 miles of this cable was procured at a cost of some $75,000,000.00.

"From the results to date," Mr. Miller and Mr. deSante reported, "it is anticipated that these new Spiral-4 connectors will overcome a serious operational and monetary problem to the military by providing more rugged connectors, allowing utilization of previous unserviceable stocks of cable lengths and allowing quick replacement of brass connectors which may become damaged in the future."

MARS April Speakers

April speakers for the First U. S. Army Military Affiliate Radio System (MARS) SSB Technical Net will include:

April 1: "Variable Reactance (Parametric) Amplifiers" by Dr. Sidney Deutsch, Associate Professor of Electrical Engineering, Polytechnic Institute of Brooklyn.

April 8: "Electro-Mechanical Filters" by Oscar P. Olson, Department Head, Research & Development, Collins Radio Company.

April 15: "Phosphors and Electro-Luminescence" by Dr. Paul Goldberg, Engineering Specialist, Sylvania Electric Products Corp.

April 22: "Atlas-Score Communications System" by Samuel P. Brown, Deputy Director, Transmission Facilities Div., U. S. Army Research and Development Laboratory, Ft. Monmouth.

April 29: "Interchanging Scientific Information by Multilateral Radio Communication" by S. Edwin Piller, W2KPQ/A2KPQ, Director, First U. S. Army MARS SSB Technical Net.

The talks will be held each Wednesday at 9 PM EST on 4030 kilocycles upper sideband.

Air Force MARS Net

The April schedule for the Air Force MARS Western Technical Net to be heard on Sundays, 2-4 PST on 7832.5 kcs, 3295 kcs, 143.46 mcs. will include:

April 5: "Automatic Multipurpose Electronic Checkout System for Military Weapons Systems or Industrial Systems" by Larry Mast, Senior Project Engineer, Packard-Bell Electronics Corp. and as Moderator for the program, Colonel Frank Shannon, USAF (Ret.), Manager, Technical Field Service, Packard-Bell Electronics Corp.

April 12: "Transistorized Amplifiers, Repeaters and Compressors for the Air Force *Quick Fit System*" by John K. Hilliard, Vice President, Altec Lansing Corp.

April 19: "Silicon Rectifiers" by The Rectifier Division, Audio Devices Corp.

April 26: "Equipment Utilization and Conversion Information" by USAF MARS W.T.N. Members.

Names in the News

Thomas W. Melia has been appointed Assistant Manager of Sperry Gyroscope Company's Surface Armament Division and **John M. Geiger** has been appointed Sales Manager.

John L. Herre, who has been a specialist in military electronics throughout his business career, has joined Raytheon Manufacturing Company's Semiconductor Division as Government and Special Accounts Sales Manager.

Colonel John A. McVey, Commander of the 507th Communications and Control Group (TAC) at Shaw AFB, was recently awarded the Air Force Commendation Medal for meritorius service. Colonel McVey is the First Vice President of the AFCEA South Carolina Chapter.

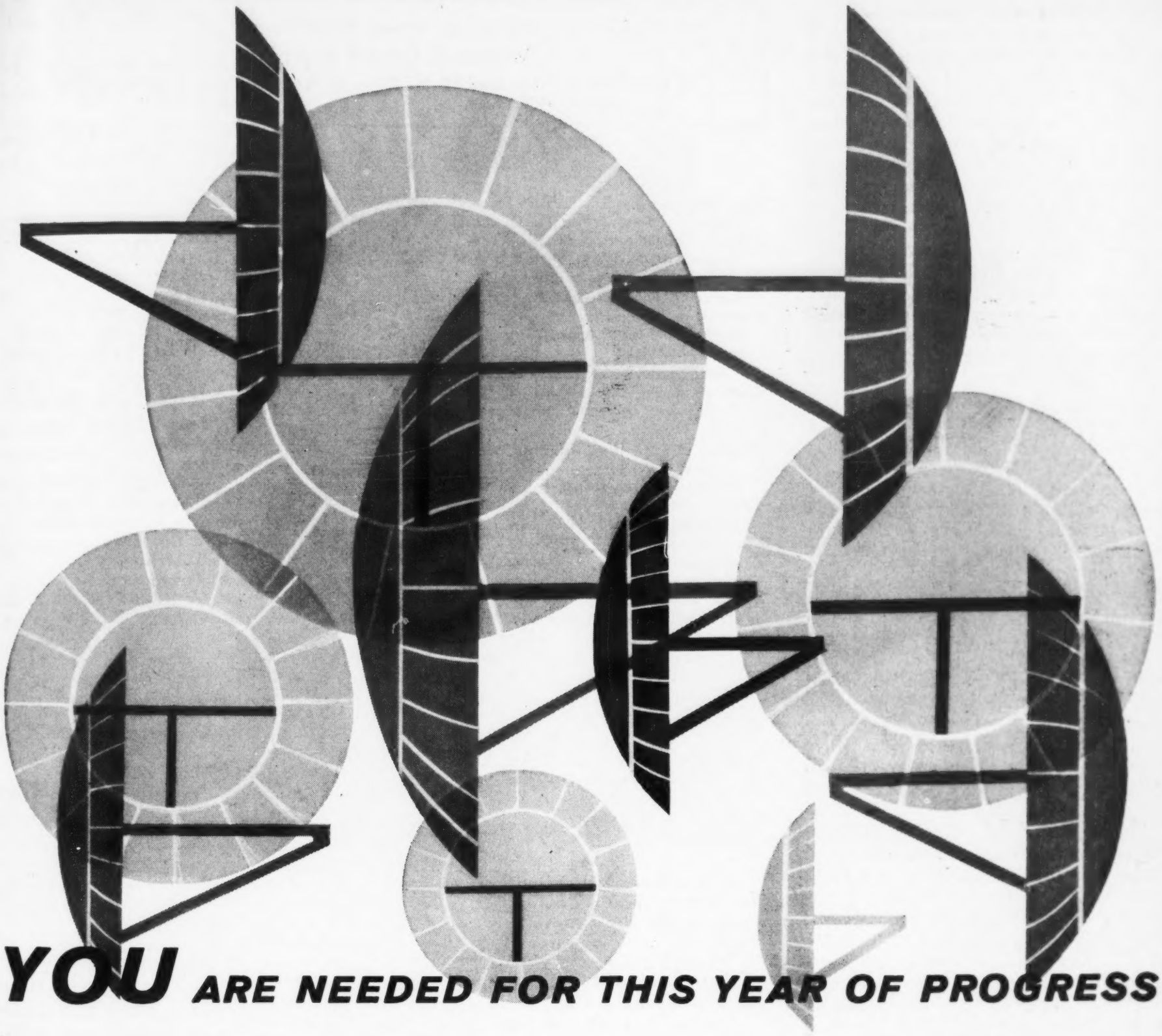
Matthew B. Thorp has been named Staff General Representative for Laboratory for Electronics, Inc., Boston, Mass., and will be headquartered in Washington, D. C. Before joining LFE, Mr. Thorp was Vice President of United Services Associates, Inc.

Colonel D. J. Bailey, USA (Ret.), is the Manager of Raytheon Manufacturing Company's new Washington offices. Colonel Bailey transferred from corporate headquarters in Waltham, Mass., where he served as a Corporate Representative on the government relations staff.

Major General George I. Back, USA (Ret.), has been elected a Director of International Resistance Company. Since 1955, General Back has been Assistant to the President of IRC. Prior to joining IRC, he was Chief Signal Officer, USA.

Maurice Parisier, President of the electronics and industrial engineering firm of Maurice I. Parisier & Company, has been awarded the Cross of "Chevalier de la Légion d'Honneur" in recognition of his contribution to French technical developments in the United States.

Dr. Mervin J. Kelly, Chairman of the Board of Bell Telephone Laboratories, was presented the 1958 James Forrestal Memorial Award given by the National Security Industrial Association for his accomplishments in furthering American defense.



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The Challenge of Space

(*Continued from page* 61)

the field of electronics. Because of the extremely high cost of any excess weight, we are faced with the problem of minimizing the weight of our electronic equipment. A great deal of work has been done in the past few years in this particular area. Whereas standard radio and television packaging techniques give a packaging density in the order of seventy components per cubic foot, the present state of the art will allow packaging in the order of 100,000 components per cubic foot and packaging densities in the order of a million components per cubic foot are within the foreseeable future.

Another major handling problem that must be solved adequately is that of equipment to handle large amounts of structural material in outer space and to enable men in space suits to carry on the work of erecting space platforms and laboratory facilities in the emptiness of outer space.

In summary, space presents a challenge to the adventurous explorer, an intriguing opportunity for the scientist to increase his knowledge of the universe, the challenge of potential commercial value to mankind, and the greatest challenge of all is the possibility that from the pursuit of the exploration of space may come a better mutual understanding among the nations of the world and the elimination of the threat of war.

The specific details of this challenge, the specific details of the rewards to be achieved, cannot be predicted. We can see in retrospect the origin of our present civilization in the geographical exploration of past centuries and of our present economy and standard of living in the technological advances of past decades. These in turn were founded upon obscure and elementary scientific discoveries. As Dr. Fred Hoyle, the famous British astronomer, recently said in *The New York Times Magazine*, "we are still very much at the beginning of the road. What has so far arisen (in recorded history) is likely to prove but a small image of what is to come. . . the nation that neglects creative thought today will assuredly have its nose ground into the dust tomorrow. . . ."

Of this we can be sure. The frontiers of science and the advances of technology today are the foundations of our entire science, technology, economy and way of life of tomorrow. If we as individuals and as a nation meet the challenge presented by this new era of space and attack it forthrightly and completely, we can be sure that it will be for the benefit of all mankind and possibly, ultimately, for the salvation of the human race. We can be equally sure that if we do not meet this challenge with every resource at our disposal, we will indeed become only a second-rate nation and may actually cease to exist as a nation at all. That, gentlemen, is The Challenge of Space.

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Burnell & Co., Inc.
Mohr & Eicoff, Inc., Adv. 28
Burroughs Corp.
Campbell-Ewald Co. 31
Camera Equipment Co.
J. M. Kesslinger & Assoc., Adv. 86
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Henry J. Kaufman & Assoc. 75
Craig Systems, Inc.
Larcom Randall Adv., Inc. 29
Electron Arc, Inc. 90
ESC Corp.
Keyes, Martin & Co. 88
Freed Transformer Co., Inc.
Franklin Adv. Agency 89
General Electric Co., Light Military Electronic Equipment Dept.
De Garmo, Inc. 38
The Hallicrafters Co.
Henry B. Kreer & Co., Inc. 47
Hoffman Electronics Corp., Hoffman Laboratories Div.
Honig-Cooper, Harrington & Miner, Inc. 43
Hughes Products, Semiconductor Div.
Foote, Cone & Belding, Inc. 85
Institute of Radio Engineers
Raymond Schoonover Adv. 91
International Telephone & Telegraph Corp.
J. M. Mathes, Inc. 78
D. S. Kennedy & Co.
Larcom Randall Adv., Inc. 1
Kleinschmidt Div., Smith-Corona Marchant, Inc.
Alex T. Franz, Inc. 36
The Martin Co.
VanSant, Dugdale & Co., Inc. 80, 81
National Electronics Executives Exchange
John B. Morrissey Co. 86
Philco Corp., Government & Industrial Div.
Maxwell Assoc., Inc. 73
Philco Corp., Lansdale Tube Co. Div.
Maxwell Assoc., Inc. 57
Prodelin, Inc.
Josephson, Cuffari & Co. 46
Radiation, Inc.
Bishopric, Green, Fielden, Inc. 71
Radio Corp. of America, Defense Electronic Products Div.
Al Paul Lefton Co., Inc. 3rd Cover
Radio Corp. of America, Semiconductor and Materials Div.
Al Paul Lefton Co., Inc. 48
Radio Research Instrument Co. 90
Raytheon Manufacturing Co.
Donahue & Coe, Inc. 26
Rheem Manufacturing Co. Defense and Technical Products Div.
Getz and Sandborg, Inc. 41
Sprague Electric Co.
Harry P. Bridge Co. 4
Stromberg-Carlson Co.
The Rumrill Co., Inc. 44, 45
Texas Instruments, Incorporated
Don L. Baxter, Inc. 63
Thompson Ramo Wooldridge Inc.
The McCarty Co. 2
Times Facsimile Corp.
Thomas & Douglas, Inc. 65
United Transformer Corp.
Shappe-Wilkes, Inc. .....2nd Cover
Varian Associates
Boland Assoc. 33
Victor Gloves Inc. 84
Western Electric Co.
Cunningham & Walsh, Inc. 60
Westinghouse Electric Corp., Defense Products Group
Ketchum, MacLeod & Grove, Inc. 52, 53
Westinghouse Electric Corp., Electronic Tube Div.
McCann-Erickson, Inc. 83

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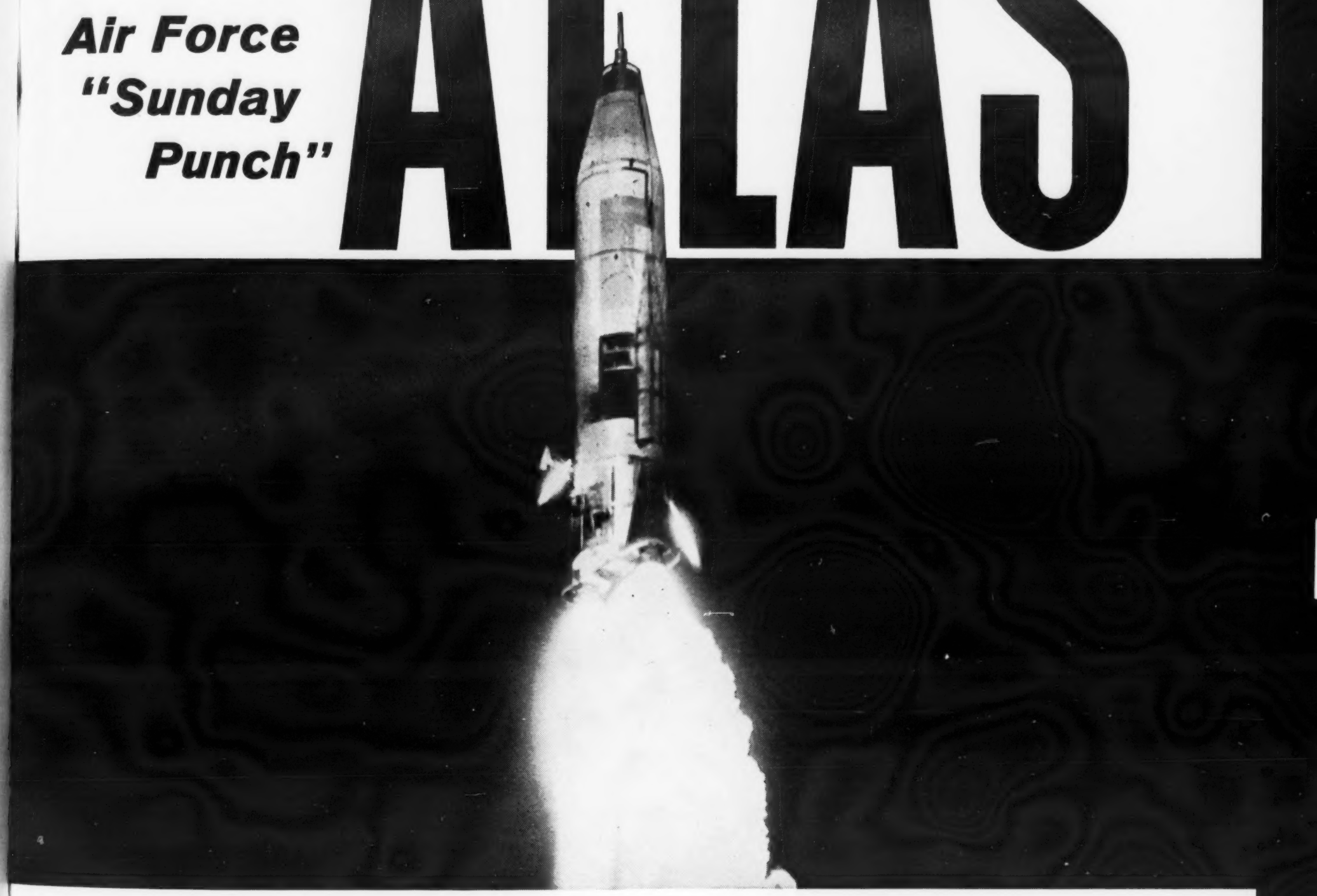

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